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Dayton Flood Plans

WHEN this issue reaches the readers there will be under way at Dayton the most important procedure the country has ever known, so far as flood prevention is concerned. The Court of Common Pleas will be listening to arguments for and against the formation of the Miami Conservancy District, through which it is proposed to construct a system of flood protection reservoirs. This week distinguished experts have been going over the data collected by the Morgan Engineering Company. The testimony should be a most valuable addition to the literature of flood prevention. Coming just at the anniversary of the disastrous flood, the hearings prompt inquiry as to what has actually been done for the protection of Dayton. About $50,000 has been expended in cleaning out the brush between the levee lines and raising the levees to a uniform height 3 ft. above the high water of the 1898 flood, a record for the valley before the 1913 inundation. Three years hence, if the Morgan plans are adopted, Dayton will be secure from damage even by a greater storm than that of last year.

Express Company Dissolves

THE dissolution of the United States Express Company, announced last week, must give thoughtful citizens pause. What is on the horizon? The parcels post and the Interstate Commerce Commission have made the business unprofitable, while the former, acclaimed a great success by its advocates, digs deep into the pockets of the railroads and increases the perilous position of the carriers. If rumors from Washington can be credited, the destruction is not yet at an end, for if the parcels-post weight limit is raised to 100 lb., the remaining three express companies will be hard hit and may have to follow the way of the United States Express Company into dissolution. The alternative will be bankruptcy, and in any event Government operation of the express business. Those who have had experience with the parcels post will pray that that may not come. We may eventually have Government ownership of the carriers, but it is safe to say that the majority of citizens are not prepared for it. It is time for the authorities in Washington to do some deep thinking.

American Telephone Service

GOVERNMENT ownership occupies a disproportionate amount of space in these columns this week, due to the passage of the Alaska railway bill, the dissolution of the United States Express Company and the annual report of the American Telephone & Telegraph Company. The subject is so important, however, that no apology for discussing its various phases is needed. If present discussion is an index, the first service to be nationalized—if nationalization comes, as seems inevitable—will be the telegraph and telephone systems. It is worth while noting, therefore, that every Government-owned telephone system incurs a deficit annually, while, on the other hand, the Bell system has shown increasing profits every year. After scrutinizing the figures one can readily believe that President Vail is sincere when he says: "Our opposition to Government operation and ownership is not based on pecuniary, partisan, prejudiced, or personal reasons. It is because of our interest in the upbuilding of a great public utility and its preservation. We are opposed to Government ownership because we know that no Government-owned telephone system in the world is giving as cheap and efficient service as the American public is getting from all its telephone companies. We do not believe that our Government would be any exception to the rule."

George Westinghouse

GEORGE WESTINGHOUSE, personification of the highest type of engineer—discoverer, organizer, inspirer of men—passed to his reward on March 12. While yet young in spirit and years he lays down the burden of an unusually eventful life. In the popular mind his name is inseparably linked with the airbrake, and, if that alone remained to his credit, his fame would be enduring, for that discovery made high-speed railroad travel, with all its remarkable consequences, possible. To those who know industrial conditions, however, the name Westinghouse stands for something bigger than the mere discovery of the airbrake. It typifies American industrial enterprise and the kind of courage that was needed to bring the electrical industry in a generation from nothing to one of the most important in the country to-day. Moreover, his activities did not cease with this country. Abroad he was as well known as here, and his properties had no less influence on industrial progress there than in his native land. Plants on both sides of the Atlantic, employing 50,000 persons, are the monument to his genius as an organizer. To his qualities as a man, with keen insight and broad sympathies, the loyalty of his tremendous organizations is an adequate tribute. To his position as a broad-minded student of affairs of the day his appointment with ex-President Cleveland and Morgan J. O'Brien as a trustee to handle the affairs of the Equitable Life Assurance Society at a time when insurance matters were in a very bad way bears ample evidence. Engineers give way to none in their admiration of his ability—an admiration tinged with pardonable pride because he was one of their number.

Government Ownership

WHAT effect will the ownership of the Alaska railway have on the general subject of government ownership? The question cannot be avoided. At present no one can answer. If the line should prove successful it would act as a stimulus to acquisition here. If it should be a failure, the effect would not be correspondingly damaging to the government-ownership cause, for the extraordinary difficulties would be pleaded in extenuation and a loss argued to be justifiable for the sake of developing Alaska's resources. If, as will probably be the case, there is neither decided success nor failure, there will be little effect on the general problem, for the dissimilarity in conditions there and in the United States proper will be sufficiently great to allow a clever talker on either side to make a case to his liking. In this journal's judgment, therefore, the Alaska experiment is likely to stand as a case by itself, arguing neither for nor against general nationalization. One point, though, should be clearly understood. Unless the system of reports and the accounting are improved over those in vogue in the Post-Office Department no light at all will be shed on the railway problem. If there are no capital charges carried into the costs—a defect in post-office accounting—the figures immediately become valueless for comparison. It is likely, of course, that the accounts will be kept in accordance with the rules of the Interstate Commerce Commission, but even then capital charges are likely to be omitted. Only by including them will the figures be of value to railroad men and the public in comparing public with private ventures.

Playing with Fire

THE danger of disaster incident to attempts to ride more than one horse at a time is well known. Not so well known, but much more to be condemned, is the taking of retainers from both sides in a lawsuit or the acceptance by members of other professions of fees from both seller and buyer, or from municipality and contractor in connection with one and the same piece of work. Dropping generalization, it appears to be necessary to say a word of warning to those whom it may concern that a scandal of the first water cannot be avoided if experts employed by municipalities in connection with paving accept employment from contractors who are doing the work. In a case of this kind the consulting engineer acting in the capacity of adviser to the city cannot properly accept even trifling laboratory fees from contractors for the examination of materials and mixtures. If he does he may be placed in the position of having approved materials, if not workmanship, which later turn out to be unsatisfactory to the municipality. If the choice were then between loyalty to the municipality or the contractor employer it would be bad enough; but it is worse than this, for the expert if he is human will not want to condemn his own work on behalf of the contractor. The result is likely to be that the expert will compromise by "letting the contractor down easy," and perhaps the evil may go so far as to result in the acceptance of work that should be rejected. In the event of paving failures there is always the opportunity for dispute as to whether faults are due to materials or workmanship and as to just how good or bad the work may be. No engineer or expert who has regard for his profession or even a sense of common decency will allow himself to occupy a position where he may be forced to compromise between the rights of clients. Considerations of common honesty, not to speak of ethics, place this beyond the region of argument. That it has seemed necessary even to make this statement of the case is an occasion for regret.

Vigorous Work Needed in Establishing Timber Standards

WHY should the user of structural timber buy a pig in a poke? The answer is that there is no reason—but, as the discussion in this journal for the past two months plainly shows, he *is* buying his timber in that way. The fault is most largely the buyer's, but the producer is also to blame, and unless he changes his ways his market will continue to suffer—and to his own loss.

The discussion, it will be remembered, was started by Mr. Hoxie's paper before the American Society of Mechanical Engineers, abstracted in this journal Jan. 17, 1914, page 66. This was followed by discussions by Messrs. von Schrenk, Weiss and Davidson, while in this issue Mr. North, than whom no one is better qualified to speak, albeit he openly represents the manufacturers', and thus a partisan, side, sums up the discussion and draws conclusions to which both consumer and producer may well give heed.

As those who have followed the discussion will realize, there is no dearth of high-grade long-leaf timber. Messrs. von Schrenk and Weiss corroborate Mr. North in this statement. Why, then, the statements of Messrs. Hoxie and Davidson that suitable timbers cannot be obtained—a view also advanced in these columns by J. J. Morgan, of Columbus, Ohio, about a year ago? It is due to lack of proper specifications, proper inspection and also to the unscrupulous practice of producers slipping in inferior with better-grade timber, relying on laxity of inspection to escape discovery.

The causes of the present situation having been ascertained, the needed remedies are evident, even if difficult to obtain. The manufacturer has graded his product solely on the basis of defects—knots, shakes, wanes, etc., while no cognizance has been taken of those qualities, such as density, that determine the strength. The producer has failed to appreciate the physical properties of his product. The user has made some progress in this direction, but even he has been curbed by the customs of the trade in writing his specifications. A rational grading would rest on the inherent strength, based on density and other physical properties, with reductions for the defects as they appear. Committee D-7 of the American Society for Testing Materials has lately been enlarged by the appointment of several producers, and it is not too much to hope that a more satisfactory specification will soon be forthcoming.

But even then the battle is not won. The producer must radically change his viewpoint. He is now out of harmony with modern high-class merchandising, and should wake up to the fact that "his game of putting things over" on the buyer has injured the reputation of his product, and, whether he has yet felt it or not, narrowed his market. It is not well for the yellow-pine manufacturer to have it believed that reliable yellow pine can no longer be obtained. But that view, unfortunately, is widely prevalent. The regrettable feature is that the honest manufacturer has suffered from the actions of the dishonest ones.

The remedy is to set standards and stamp timber with certified brands, and according to an approved grading. The progressive producers in inaugurating any such scheme would secure the instant backing of engineers and architects. The dishonest manufacturer would have to quit, or sell his wares for what they really are. Oregon apples, no better than the Eastern brands, control the market in Chicago and New York because the pack is guaranteed by the producers' associations. The same idea must be applied to timber, and the sooner the scheme is adopted the sooner will timber regain in the minds of engineers the position which was lost through poor specifications, poor inspection and lax and unscrupulous marketing.

Tests of Model Bridge Members

DESTRUCTION tests of great value in the investigation of the tensile and compressive strengths of large-size carbon and nickel-steel bridge members have recently been made and are reported in part on page 333 of this issue. All of these tests were made on models, of about one-quarter scale, of web and chord members designed for the center suspended span, the anchor and the cantilever arms of the new Quebec Bridge. They are of importance on account of the large size of the members, the elaborate record of measurements of distortion, the special pains taken to determine the comparative efficiency of the details, the relative strength of the connections and of the main body of the specimen, the information derived concerning the strength and properties of the latest types of large compression members, the effect of tension on riveted plate members and on built members suitable for resisting alternating stresses, and particularly on account of the valuable comparative results of similar tests on duplicates of large carbon and nickel-steel compression members. The analysis of the results obtained will also be of value in determining the efficiency of pin connections, reinforcements, latticing, and other details, while the numerous gage readings at the ends of the pieces provide valuable indications of the distribution of stress from the pins to the web members. The remarkably high ratio between the elastic limit of the nickel and carbon-steel members indicates, so far as it goes, a very great advantage in working strength of nickel-steel over carbon-steel compression members and warrants a continuation of the investigation along these lines to determine the most advantageous design for the primary members of long-span trusses. The great care with which the tests were made, observed and recorded, as they were by experts of long experience, makes them authoritative and establishes their value for analysis and comparison.

Earthquake-Proof Tower

THE steel and concrete tower, about 300 ft. high, which was described on page 312 of last week's issue has some peculiar features adopted with the idea of resisting severe earthquake shocks. It has a framework of substantially vertical steel columns connected at frequent intervals by horizontal diaphragms. The vertical panels between the diaphragms are alternately braced and unbraced, thus making the framework of successively rigid and flexible sections. This provides for the deflection and horizontal displacement in several zones separated by other zones constructed to resist such movements.

The vertical bracing, instead of acting as continuous cantilever trusses from top to bottom of the tower and transmitting all of the transverse stresses to the foundation, can only act as separate units, stiffening the columns and concentrating the bending moments of the latter. This system reduces the strength and amount of diagonal bracing at the expense of the columns, which have to transmit all of the horizontal stresses and are subjected to heavy bending. The feet of the columns are anchored to grillages embedded in a massive concrete base with an area about twice as large as that of the maximum cross-section of the tower.

The details, specifications and character of foundation give reasonable assurance that the tower will resist earthquake shocks and wind pressures as well or better than structures not as strong or as well built which have proved successful under severe conditions in the same locality. It does not follow, however, that such an indeterminate and mixed method of construction is the best for vibrations and wind stresses, the most important stresses to which it is exposed. The provision of points of contraflexure and the location of column joints at the centers of the unbraced column panels induce objectionable column stresses and excessive bending from wind pressure and suggest, at least, a sinuous, wave-like motion with nodes at the points of contraflexure under earthquake vibrations. Their increasing amplitude, under prolonged tremors, would be dangerous for the solid and inelastic masonry and for the riveted connections of the steelwork, thus defeating one of the principal objects of the construction, which is to relieve the riveted joints.

The seismic vibrations are, of course, irresistible and must expend their force in doing mechanical work. It does not seem necessary that this work should be absorbed in the flexure of heavy columns and in the disintegration and distortion of units of a tower, when the latter may readily utilize its potential strength by a system of trussing which will give it abundant rigidity to move slightly as a whole, yielding to transverse displacement as a bridge yields to inevitable vertical displacement.

Alaska Railway Bill Becomes Law

THE Alaska railway bill became law by the signature of the President on March 12. For the first time in our history we are to embark on Government construction of an extensive railway, half a century after, with the same end in view—the development of new territory—the nation extended aid to the Union Pacific. If a loan were justified under conditions obtaining then, Government construction is warranted now in the case of Alaska. When the West was opening up there were tempting prizes in new lands, forests and minerals, to be acquired outright at little or no cost and to be exploited as the newcomer saw fit. Today a different spirit rules. Coal lands and other valuable properties in Alaska are not to be given away. Ownership is to vest in the nation and operation is to be on a leasing basis with some return, or reversion after a fixed period, to the Government. The attractions to capital are, therefore, less than they were in the West, and if the territory is to be developed rapidly it will only be through Government aid.

In its original form the bill had provisions that, fortunately, were removed before final passage. Two of these were that all employees should be subject to the army engineers, thus virtually putting the enterprise under that branch of the Government, and that all civilian engineers receiving $3000 or more per annum should be appointed subject to the approval of the Senate. The first would have placed the work in charge of those not specially qualified for it by experience and the second would have made every major civilian appointee play politics.

Nevertheless, defects remain in the measure. The provision that the price paid for existing lines shall not exceed the actual physical value to the railroad is unfair and unjust. Development expenses must be considered in fixing a fair price. Moreover, the authorization of the transfer of the Panama equipment is a snare and a delusion. Most of it will be scrap when the canal is finished.

The passage of the act just at the time that a $40,000,000 waste is reported on a line built by the Canadian Government naturally suggests thoughts regarding the management of the Alaska enterprise. There is evidence in the Canadian matter that the chief faults were a lack of common sense, fear of popular criticism if sound engineering rather than popular clamor were the guide, and finally extravagance due to the security engendered by the apparently unlimited backing of the Dominion Government. The President, in building his railway-construction organization, might well ponder the Canadian report and prepare therefrom slogans to be preached constantly to his appointees. The courage that the President has shown in other matters is a promise that a vigorous policy will prevail if he allows his interest in the enterprise to continue. Politics particularly must be kept out of the management—politics and its resulting wire-pulling for the fat contracts in sight. Otherwise the absurdities with which Senators and Representatives dotted the hearings on the bill will not merely remain to enliven the dull pages of the "Congressional Record" but will be translated into inefficiency in location and construction.

The Alaska railway measure is fully justified. That it may not be a discredit to American politics, honesty and ability is the prayer of laymen and engineers alike.

Report on the Montreal Conduit Accident

THE recent report on the break and repair of the Montreal conduit is none too strong in emphasizing the serious nature of such a failure. Fortunately it does not often happen that the water supply of a large city is completely interrupted, but Montreal is the second large city in Canada to suffer such complete interruption within the last few years. Besides the privation and inconvenience resulting from a lack of the usual water supply, there is the actual menace to the health of the city that would result if the interruption were prolonged, from the suspension of the normal use of the sewer system that would follow, and from the emergency use of various supplies of water, many of which would probably be inferior in sanitary quality to the regular supply.

Not the least serious is the fire menace. Following such an interruption as this a city is left quite unprotected, and it is not pleasant to think of the disastrous consequences of a vigorous fire under such conditions.

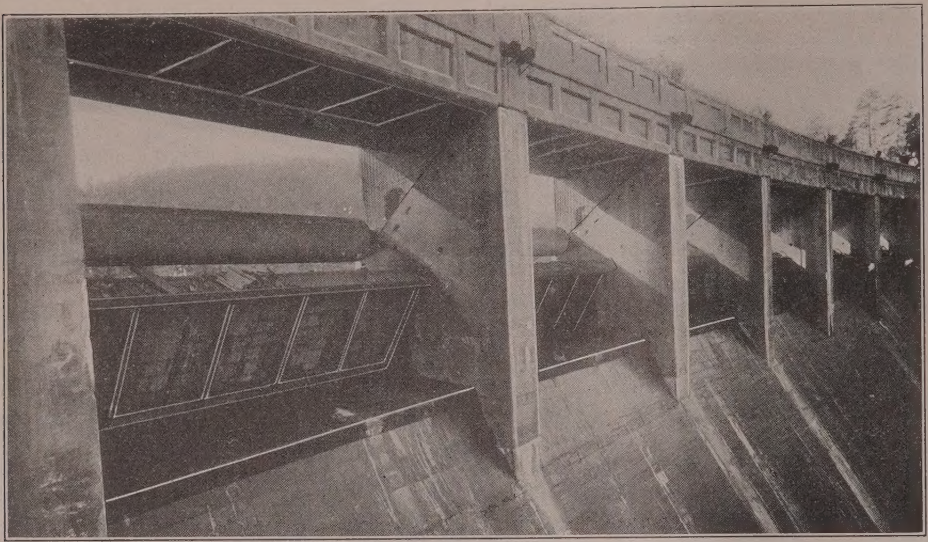
The conclusions in this report indicate, throughout, inadequacy, first, in the design of the structures, and, second, in the protection of the structures against damage through the proximity of other and later work. Such matters as insufficiency of steel reinforcing and the removal of lateral support from a structure, which, through such an inherent weakness, must depend for stability upon the action of a light masonry arch and the backing of a material whose lateral supporting power is uncertain under unfavorable conditions, would seem to be fundamental, and the report itself is more forcible than any comment thereon.

Structures are sometimes distorted in shape by slow settlement or solidification, or shifting of materials, but form a system in equilibrium with those materials. Structures in this condition may, and sometimes do, serve safely for an indefinite period. This implies, however, an insufficient margin of safety, if not in the original design at least in the conditions thus developed. Since we cannot always feel confident that a condition of this sort has not developed, extreme caution is imperative in the overloading of structures, in the relieving of stresses, or in any manner changing the conditions of equilibrium, in order to guard against introducing other conditions not contemplated in the design of the structures, such as in this case contributed to the failure.

There is a tendency on the part of many cities to undertake the design and construction of works of various kinds with their own engineering forces. To a certain extent, of course, that is the primary reason for the existence of the engineering departments of city organizations. It is not always a wise policy, however, to proceed without other and more experienced advice. The motives naturally given for this policy have been heard summed up in the following words: "We can save engineers' fees and can do it well enough ourselves." This policy has different results. The case in question is a most unfortunate example of the serious danger—to say nothing of the inconvenience—in which it can place a community. At the other extreme this policy sometimes results in designs which are unnecessarily strong. Those responsible for them, in their inability to turn out a design combining the virtues of safety and economy, hide behind the argument that it is better to be sure than sorry; but they are often responsible in this way for the most reprehensible extravagance.

Mention is made in the report of certain gates that were found to be in bad repair and entirely useless at the time they were wanted. This, of course, had nothing to do with the actual failure of the conduit, but there are frequent instances of troubles of greater or less magnitude that could have been avoided by more scrupulous attention to gates or other devices. In the hands of the average man in charge of the operation of an engineering structure such apparenty minor details as gates may appear unimportant while they are not actually needed. The board's comment serves to emphasize the importance of having systematic inspection and maintenance of such vital parts of a structure.

This report, not only in the points above mentioned but in others of less direct bearing upon the main subject, may be studied with profit to show the advantages and economy of putting matters of important and intricate design in the hands of engineers whose experience in their line insures completeness, safety and economy.



Downstream View of Dam, Showing Automatically Operating Flashboards

Highest-Head Hydroelectric Plant East of Mississippi River

Part I — Developing 17,000 Horsepower under 580-Foot Head at Tallulah Falls, Georgia, Involves Concrete Dam with Automatically Operating Flashboards

By CHARLES G. ADSIT, Construction Engineer and EUGENE LAUCHLI, Hydraulic Engineer

RANKING as the highest-head hydroelectric plant east of the Mississippi River, and one of the highest in the world using water turbines, the Tallulah Falls development, situated on the eastern slope of the Blue Ridge Mountains, in Rabun County, Georgia, was put in operation during September, 1913. Few plants of its magnitude have the natural advantages of as great a rainfall, absence of extremely low temperature, the gain of about 500 ft. head in a little more than a mile of stream length, adequate site available for the creation of storage reservoirs so close to the generating plant, and adequate railroad facilities. The Tallulah River, a tributary of the Savannah, rises in Macon County, North Carolina, and in the northwestern part of Rabun County, Georgia, and flows in a southeasterly direction, forming part of the Savannah watershed. Part of its course is cut through the solid rock, forming canyons and steep bluffs; throughout the greater part of its course the fall is very rapid. At least 80 per cent of the drainage area is timbered.

HYDROGRAPHIC CONDITIONS

The annual rainfall varies from 70 to 80 in.; the highest temperature is 102 deg. Fahr.; the lowest, about 5 deg., with a mean of 58 deg.

A gaging station ½ mile above the intake works at Tallulah Falls furnished information as to the flow available during high and low-water stages. The drainage area above the gaging station is 191 square miles. The river channel at the gaging station is straight, with rocky banks, not subjected to overflow. The bed of the stream is composed of rock, and is permanent; the current is swift and there is but one channel at all stages. Discharge measurements were made from an iron highway bridge having a single span of 100 ft.

From the accompanying hydrograph, covering a period of fourteen years, it will be observed that the lowest average monthly flow of the river ever recorded was 135 sec.-ft. and that the driest months are usually September, October and November.

The minimum and maximum flows recorded correspond to a runoff of 0.65 and 79 sec.-ft. per square mile respectively. Floods of from 5000 to 8000 sec.-ft. are quite usual during the spring season, and a flood of 15,000 sec.-ft. has been recorded in March.

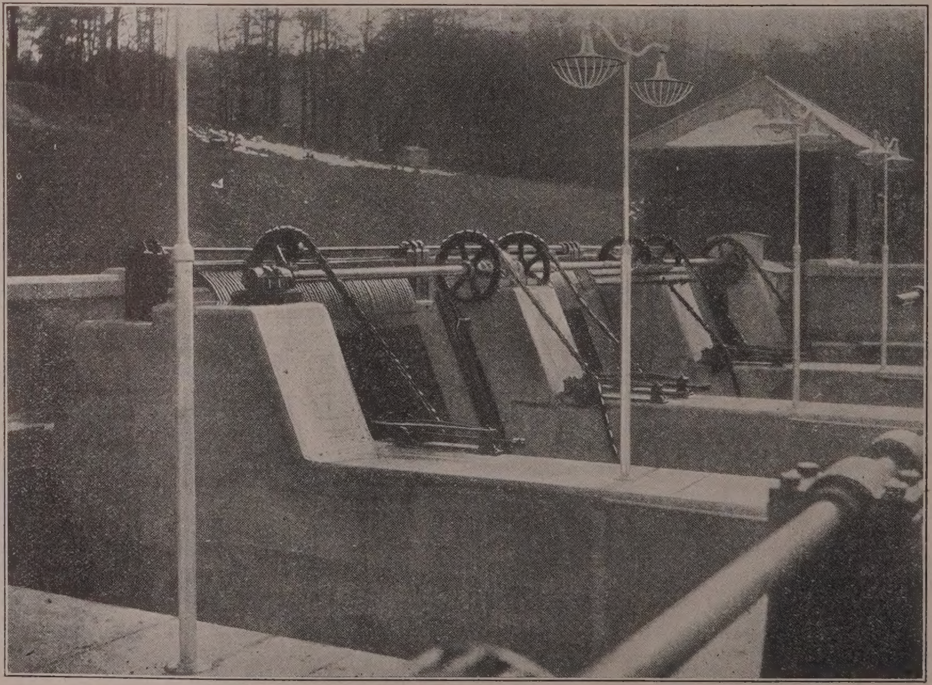
GENERAL DESCRIPTION

The following features and structures are involved in the development: An artificial reservoir with a capacity of 1,000,000,000 cu. ft. formed by two reinforced-concrete buttressed dams located at Mathis, Ga., 7 miles above the intake works at Tallulah Falls; an artificial reservoir having a pondage of 63,000,000 cu. ft., located at Tallulah Falls, formed by the construction of a concrete dam about 60 ft. below the intake works of the tunnel; a tunnel, 6665 ft. long, leading from the above reservoir to a surge or pressure tank, and five 5-ft. diameter steel penstocks, each of which serve one unit in the power house.

Different designs were studied at various times by several interests, and although, generally speaking, little difference of opinion prevailed as to the location of the intake dam and of the power house, various means of conveying water to the turbines were investigated and proposed. These schemes included an open canal blasted out of the steep sides of the gorge, a pressure tunnel driven on a steep slope and subjected to about 300-lb. pressure leading directly from the intake works to the turbines, etc. In 1911 the final plans were drawn, including none of the above-proposed schemes, and work was begun almost immediately.

In the final plan a gravity rubble masonry dam and grade tunnel were selected. All structures and machinery were so located or designed as to insure reliability in service. For this reason a masonry-lined tunnel and five lines of steel penstocks, one for each unit, laid above ground and accessible at any time for inspection, were adopted. Those parts which required frequent repairs were multiplied as far as could be done. This called for multiple intake gates and racks, several safety gates and valves for the penstocks, a double system of oil pumps for the turbine bearings, and adequate provision for testing the efficiency of the turbines by three different methods.

By building a diverting dam 110 ft. high, a gross head of 606 ft. was made available for power purposes. The dam also created an impounding basin 1½ miles long, having a capacity of 106,000,000 cu. ft., 63,000,000 of which are available for the waterwheels. The addition of flashboards 6 ft. high permitted the pond level to be brought up to El. 1500, thus increasing the pondage capacity by 52 per cent. The accompanying



Arrangement of Rack Cleaners on Top of Intake Structure diagram shows the total pondage capacity—that available for power purposes and that gained by using flashboards.

THREE TYPES OF DAM

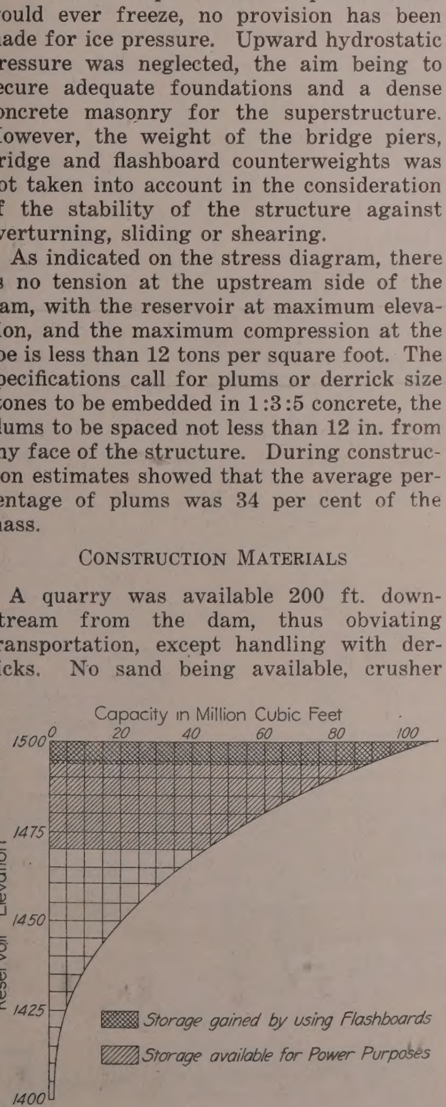
Three types of structures were considered for damming the river at this point. Because of the uncertainty as to the behavior of the strata at the upper part of the dam when subjected to horizontal thrust, a concrete dam of the pure arch type was disregarded. Owing to the unusually favorable location of a quarrying site, together with excellent foundations available for a gravity dam, the cost of a reinforced-concrete buttressed dam showed that a structure of the gravity type would undoubtedly be more economical.

The accompanying drawings illustrate the design selected, consisting of a rubble masonry dam curved to a radius of 900 ft. The dam carries at its crest a highway bridge, with a 12-ft. roadway, designed to carry, in addition to its dead load, a live load of 100 lb. per square foot. The piers carrying the bridge are 4 ft. thick and spaced 32 ft. on centers, thus leaving 28 ft. in clear for the overflow. The total length of the spillway is 280 ft., which, with two 5-ft. diameter sluiceways, has a total discharge capacity of 20,000 sec.-ft.—an excess of 33 per cent over the largest flood ever recorded. The dam is designed as a gravity section, its curvature being disregarded entirely in all calculations for stability. As it was not anticipated that the pond surface would ever freeze, no provision has been made for ice pressure. Upward hydrostatic pressure was neglected, the aim being to secure adequate foundations and a dense concrete masonry for the superstructure. However, the weight of the bridge piers, bridge and flashboard counterweights was not taken into account in the consideration of the stability of the structure against overturning, sliding or shearing.

As indicated on the stress diagram, there is no tension at the upstream side of the dam, with the reservoir at maximum elevation, and the maximum compression at the toe is less than 12 tons per square foot. The specifications call for plums or derrick size stones to be embedded in 1:3:5 concrete, the plums to be spaced not less than 12 in. from any face of the structure. During construction estimates showed that the average percentage of plums was 34 per cent of the mass.

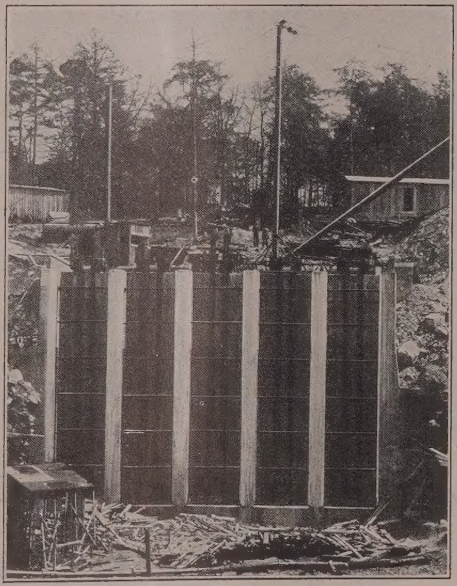
CONSTRUCTION MATERIALS

A quarry was available 200 ft. downstream from the dam, thus obviating transportation, except handling with derricks. No sand being available, crusher product screened so as to reject all particles more than ¼ in. in diameter was used. Royal Portland cement was sold the subcontractor, the Hardaway Contracting Company, by the general contractor, the Northern Contracting Company, at the railroad siding for the price of $1.80, less 10 cents for sacks. The general contractor also furnished free of cost 1000 cu. ft. of air per minute, at 100 lb. pressure, as well as electric current for lighting purposes. The quantities of materials involved in the construction of the dam included 10,600 cu. yd. of excavation and 39,200 cu. yd. of cyclopean masonry. The contract price for excavation was $1.50 per cubic yard; that for cyclopean masonry, concrete in piers and abutments, $4.80 per cubic yard.



Storage Diagram of Tallulah Falls Reservoir

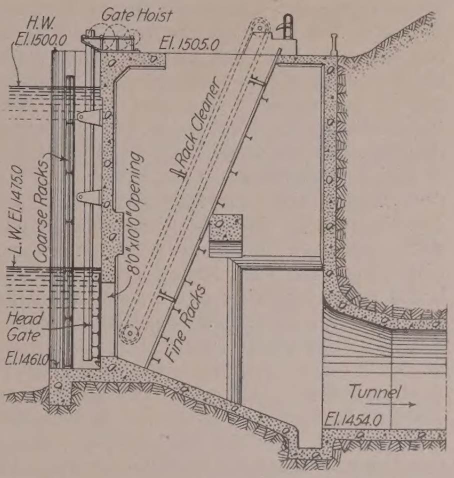
Excavation for the foundation was begun in August, 1911. The first concrete was laid during October, 1911, and was continued thereafter at the rate of about 1000 cu. yd. per week. In general, little difficulty was encountered during construction. In March, 1912, a flood of 12,000 sec.-ft. took place, taking away some of the formwork and about 250 yd. of concrete.



Tunnel Intake with Racks

To prevent the development of cracks at the crest due to temperature stresses and vibrations caused by the falling sheet of water, twelve lines of steel rails were laid longitudinally, 6 in. from the face and 4 ft. on centers, over and along the crest and down 20 ft. on the up and downstream sides of the structure. A force of ninety to one hundred men worked ten hours daily on the construction of the dam.

During construction the temperature at the dam site varied from 10 to 120 deg. Fahr., yet only one temperature crack developed. It was located in the third bay at the east end of the dam and extended for about 20 ft. down from the crest. Leakage was noticed in the lower 3 ft. of the crack, but a few shovelfuls of ashes and cinders dropped on the upstream side of the dam stopped the leak in a few hours. Immediately after water had reached the crest—at a time when the masonry had not yet taken the temperature of water (average, 70 deg. Fahr.)—the horizontal downstream displacement of the arched crest was measured and found to be ⅛ in. Measurements taken two months later, when the structure had cooled, showed a deflection of ¼ in.



Sectional Elevation of Tunnel Intake

The highway bridge is made of riveted steel girders 36 in. deep, embedded in concrete as a protection against corrosion. On the upstream side of the bridge two gate hoists, carried on steel brackets, are provided and command the operation of two 5-ft. diameter sluice gates, operating under a maximum head of 75 ft.

AUTOMATICALLY OPERATING FLASHBOARDS

Hand-operated winches have been supplied on the downstream side of the roadway to operate the automatic flashboards when necessary. Six of these have been installed at the east end of the dam to take care of ordinary spring or other normal floods. Their chief duty is to keep the pond level at a constant elevation and to drop slowly when the pond level rises 3 in. above El. 1500, and continue their downward movement when the river flow increases, until they rest flat on the dam crest. They are adjusted to return to their normal position at an angle of 60 deg. with the horizontal as the flow subsides, always maintaining the water level at about the same elevation.

Each flashboard is composed of a movable panel 28 ft. long and 7 ft. high, made up of a structural-steel frame with timber decking. At the lower end it is hinged to the dam crest with six cast-steel hinges and bronze pins. The water seal at the hinge is accomplished by a ⅛-in. steel plate with leather facing pressing on a curved steel longitudinal piece riveted at the lower end of the flashboard panel. At each end a ¾-in. clearance is provided between the bridge pier and the panel. Bronze sheet strips, fastened to the ends of the flashboard panel for the purpose of making a watertight joint, press firmly against the bridge piers.

The counterweight is 28 ft. long, 3 ft. 3 in. in diameter and weighs 34,000 lb. At each end it rests on a track. The curvature of this track is figured so as to compensate for the different loadings corresponding to the different positions taken by the flashboard. The counterweight is provided at each end with cast-iron geared drums engaging a rack, thus preventing slipping when subjected to the pull of the end cables. A 12-in. diameter wrought-iron pipe inclosed in concrete, reinforced with 1¼-in.-diameter steel rods, connects the two end drums. A 1¼-in.-diameter plow-steel cable connects each end of the flashboard to the counterweight drums, winding around these in grooves. The principle of the flashboard, its counterweight and track is therefore a balancing of moments. The hydrostatic pressure on the flashboard gives through the rope and drums a moment tending to roll the counterweight up the track, while the dead load of the counterweight tends to roll it downward. The track is so constructed that the lever arms for the forces change when the weight moves, thus giving moments that balance each other. As the dead load of the counterweight is constant and the pull on the rope due to the hydrostatic pressure increases when the water level rises, the track is not a straight line, but a curve, with its convex side pointing upward. With the flashboard in its lowest position, the counterweight is, therefore, at its highest, offering no obstruction to floating débris. Actually trees 60 ft. long and 2 ft. in diameter, twigs and débris of all sorts passed over the flashboards without causing any damage to the flashboard panels, counterweights or end cables.

FLASHBOARDS

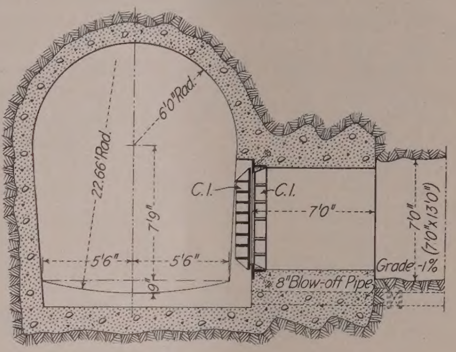
In addition to these automatic flashboards there are four others of the same dimensions, designed to give way when the reservoir is 1 ft. above their tops. They consist of long-leaf yellow-pine boards 4 in. thick, bolted to 4-in.-diameter extra-strong wrought-iron pipes spaced 3 ft. 7 in. on centers. These pipes are at their lower ends inserted in 5-in.-diameter pipes 2 ft. 3 in. long, embedded in the masonry, and enable the 4-in. pipes to be replaced rapidly when bent or broken. The function of these flashboards is, therefore, to stand up until the moment on the pipes due to the hydrostatic pressure is large enough to bend them.

INTAKE

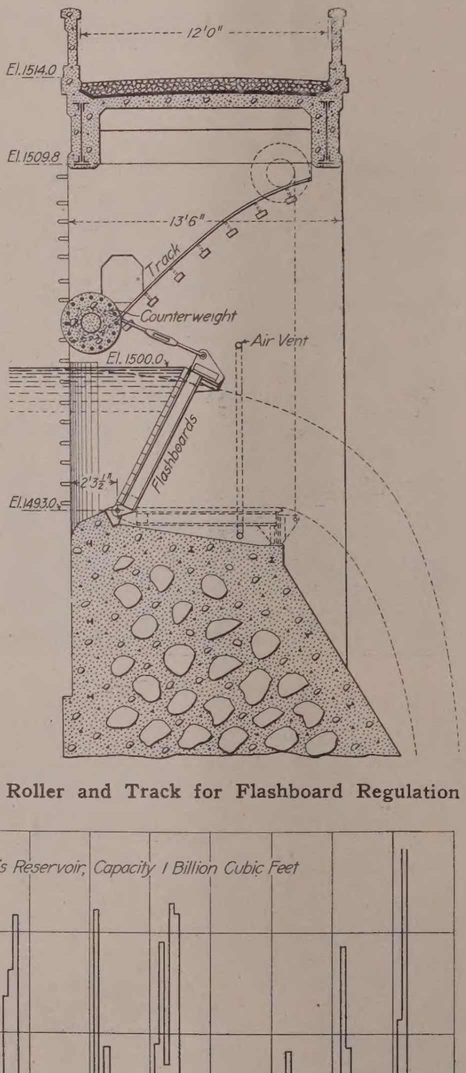
The intake is a self-contained reinforced-concrete structure, designed like a caisson, to resist the stresses caused by hydrostatic pressure, with the pond at maximum elevation and the intake empty.

During the excavation period it became evident that owing to the stratified condition of the rock water would exert considerable pressure on the outside walls and floor of the intake. This was only too well demonstrated later on when the intake was subjected to the full hydrostatic pressure. It was then found that water oozed through the side and back walls in several places. The task of designing large wall areas strong enough to resist a hydrostatic pressure of about 50 ft. was accomplished by dividing the intake into five bays, 10 ft. wide. The load on the front wall is, therefore, transmitted to the rear wall by four plain concrete walls, 3 ft. thick. By inserting an arched concrete beam at El. 1483, to take the thrust of the end walls, these are divided into panels of short span.

This structure involved about 7000 cu. yd. of excavation, mostly rock, and 2500 cu. yd. of concrete. The reinforcement consisted chiefly of 7/8-in.-diameter rods, spaced 3 in. or more on centers. The specifications called for 1:3:5 concrete.



Tunnel and Bulkhead at Adit 3



Roller and Track for Flashboard Regulation

In plan the intake was located so as to make an angle of less than 90 deg. with the dam, so that by lowering one or two automatic flashboards at the east side of the dam trees and other large floating débris can be kept away from the intake racks. No ice being anticipated, these racks were made up of 5/8-in. round rods spaced 4 in. on centers and placed in front of the head gates, thus preventing large débris from interfering with the operation.

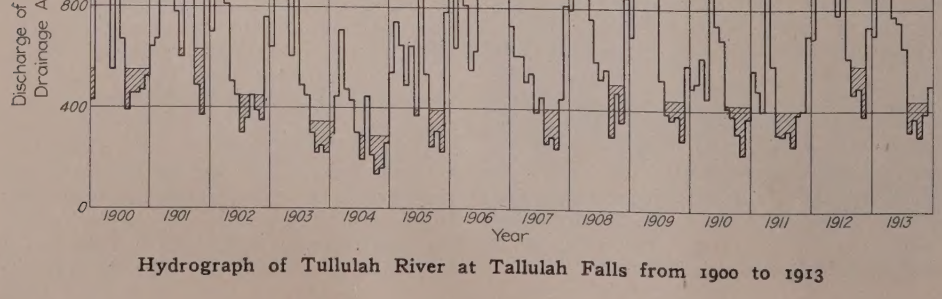
RACKS

In order to keep the fine racks free from leaves and smaller débris, the five 8 x 10-ft. gate openings were given as much submergence as was practicable. The fine rack area was made ample, thereby reducing the velocity of the water. The intake was designed to pass a maximum of 1700 sec.-ft., and under these conditions the velocity through the coarse and fine racks with the pond at El. 1500 is 1 and 1.27 ft. per second respectively. The velocity through the gate openings is about 5 ft. per second. It is evident that under such conditions the inconvenience of rack obstruction is reduced to a minimum. The fine racks are made of 4 x 3/8-in. flats, 1¼ in. apart, carried by 12-in. 31.5-lb. I-beams in the lower bay and by 8-in. 18-lb. I-beams in the upper bay.

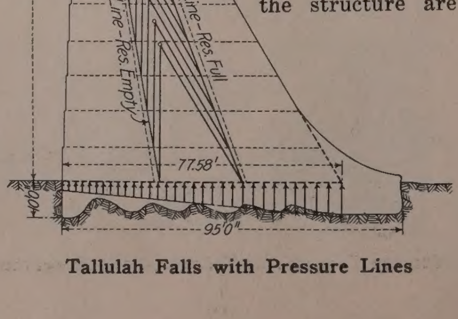
RACK-CLEANING DEVICE

Three bays of racks are made continuous from the top to the bottom of the intake, and provided with a rack cleaner driven by a 5-hp, 220-volt, three-phase, 60-cycle induction motor with starting compensator and revolving at a rate of 565 r.p.m. The main shaft is actuated through a worm gear. Each set of racks, 10 ft. wide per bay, is cleaned by three rakes placed in a staggered position and mounted on link chains at each end. The chains revolve on sprocket wheels located at top and bottom of the intake, the upper sprocket wheel being mounted on the main shaft. One rack being 3 ft. 4 in. wide, only one-third of the rack section is cleaned up by one rake, and it takes a complete revolution of the raking machinery to clean up one bay.

The rakes travel at a speed of 3 ft. per minute, and each rack is designed to resist a pressure of 100 lb. per linear foot of rake, or 1000 lb. per bay. At the top of each bay an adjustable iron comb catches the débris collected by the rakes and drops it on the floor of the intake. The remaining two bays of the structure are



Hydrograph of Tullulah River at Tallulah Falls from 1900 to 1913



Tallulah Falls with Pressure Lines

stepped at El. 1483, thus enabling the upper and lower tiers of racks to be raked by hand when the pond level is at maximum and minimum elevations.

After four months' operation it has not been found necessary to clean any of the racks, and the aim sought to keep the coarse and fine racks unobstructed with a minimum amount of attendance seems to have been attained.

The head gates are riveted up of steel plates and beams, with bronze sliding strips, and are hand operated through five S. Morgan-Smith Company's gate hoists. The intake, as well as the highway bridge over the dam, is provided with electric lights to render easy incidental night operations.

Beginning at the intake, a concrete-lined tunnel 6665 ft. long, having a net area of 151 sq. ft., conveys the water to the surge reservoir located at the upper end of the penstocks. The construction of this tunnel was described in the Engineering Record of April 12, 1913, page 396. From a purely hydraulic standpoint a circular section would have been somewhat more favorable to serve the purpose, but as no external hydrostatic pressure of any magnitude was anticipated, and for the sake of driving and lining the bore, a section with straight battered side walls was adopted. In Kutter's formula the value of n was made 0.014, thus making $C = 130$. At normal load of 50,000 kw and overload capacity of 62,500 kw, and with the reservoir at El. 1500, the velocities in the tunnel are 8.1 and 10.9 ft. respectively, corresponding to losses of head of 7.2 and 14 ft. In locating the tunnel the aim was to make the overburden overbalance the internal hydrostatic pressure, regardless of the strength or cohesion of the rock penetrated. The specifications called for a concrete lining having a minimum thickness of 6 in. and for the excavation not to extend more than 15 in. beyond the inside face of the concrete. The tunnel was driven on a 0.2 per cent grade, sloping from the intake down to the forebay through a gray, bluish granite, dipping downstream at an angle of 22 deg., with occasional mud seams. The ground generally stood up well, and only 6 per cent of the tunnel length required timbering. Of the tunnel length, 75 per cent was driven with a top heading and bench, and the remainder with a bottom heading, the overlying material being stoped down on the heading floor.

This work involved 54,000 cu. yd. of rock excavation and 19,000 cu. yd. of concrete. The cost of the tunnel, exclusive of adits and shaft, was as follows:

	Per lin. ft.
Rock excavation	$47.50
Concrete lining	34.00
Grouting	3.50
Total	$85.00

For the purpose of expediting the work it was found desirable to drive the tunnel from the intake and forebay ends, as well as from three adits and one shaft. After the completion of the tunnel all adits except adit 3 were closed with concrete bulkheads. Adit 3 was provided with a cast-iron bulkhead and with an 8-in. diameter drain valve.

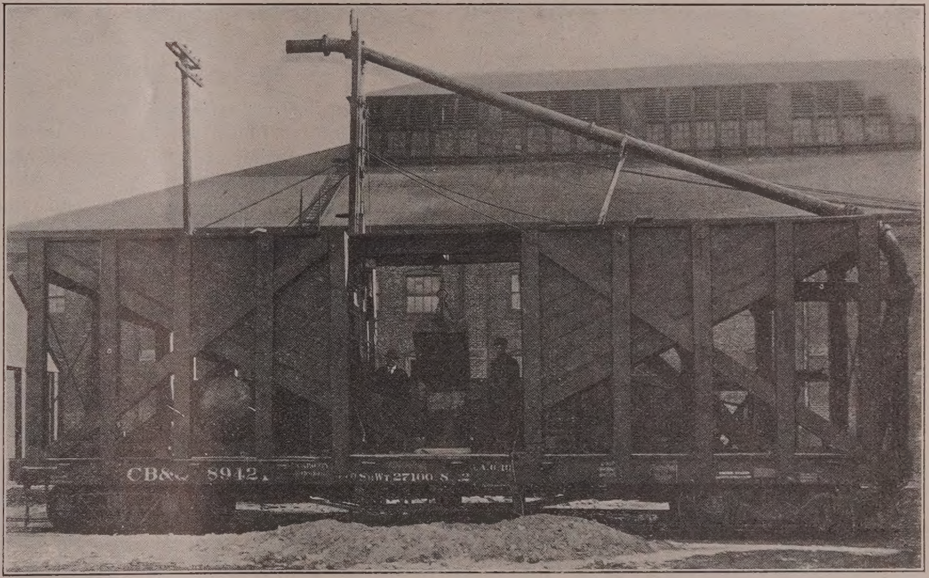
(*To be concluded.*)

SOUTHERN States spent about $40,000,000 on public roads in 1913, according to a bulletin sent out from the headquarters of the American Road Congress.

Car for Pneumatic Placing of Tunnel Lining

C., B. & Q. Railroad to Use Special Outfit for 1000-Foot Bore

LINING a 1000-ft. tunnel on the Chicago, Burlington & Quincy Railroad between Caspar and Bonneville, Wyo., will be accomplished from a 40-ft. flat car equipped with aggregate hoppers and a pneumatic mixer and conveyor. The tunnel was driven through rather poor rock, so that it is now shored. The timbers will be removed 10 ft. at a time and sections of the same length concreted behind Blaw-steel forms. The lining will be about 2 ft. thick, with vertical side walls 16 ft. high to the springing line of the semicircular arch of 6 ft. radius. Bank-run gravel will be used and the capacity of the hoppers, 705 cu. ft., will be sufficient for over one-half of a section. The overbreak is considerable and will probably run 1½ cu. yd. above the 5½ cu. yd. required per foot within the neat lines.



Tunnel Lining Car for Mixing Concrete and Placing It Pneumatically

Both bins slope toward the center of the car, where they discharge through chutes into a measuring hopper. Cement is stored in bags under one of the bins, which is 18 in. narrower than the car to permit a man to carry the bags up a slight incline to the mixer platform. The measuring hopper is lifted and tilted to discharge into the mixer by means of a cable operated by a small air cylinder. Air to operate this cylinder and to supply a large receiver operating the mixer is obtained from a pipe laid on the track the full length of the tunnel. Water is furnished to a small tank in the corner of one of the hoppers from a pipe paralleling the air line.

PNEUMATIC CONCRETE PLACING

The 8-in. pipe which conveys the concrete from the mixer to the tunnel forms runs from the mixer under the car, up at the end to the top of the bins, 14 ft. above the rail, and thence on an incline to a point 24 ft. above the rail, where it enters through a bulkhead of the tunnel form, a slot being left to shift the end of the pipe slightly, depending on which wall of the tunnel it is desired to fill. The inclined pipe is raised and lowered between wooden guides by a cable attached to an air cylinder. The guides may then be folded down out of the way, giving 16 ft. of head room for braces.

In testing the installation, the velocity of the concrete at the muzzle under 80 lb. pressure was estimated roughly at 75 ft. per second. This was determined from photographing the discharge with the pipe outlet level and noting the drop in a given distance. Four to five seconds were required for the passage of a charge which fell on the ground, 24 ft. below the pipe, from 50 to 150 ft. away.

Four men comprise the crew—a foreman who operates the mixer and all valves, a cement carrier, a man to untie the bags and empty them and one man to manipulate the aggregate hopper gates.

The car was built at the Havelock shops of the railroad from designs furnished by the Concrete Mixing & Placing Company, of Chicago. H. B. Kirkland, president of the latter company, will personally supervise the work, which will be carried out by force account under the general direction of F. T. Darrow, engineer of lines West, reporting to C. H. Cartlidge, bridge engineer, and T. E. Calvert, chief engineer.

Catskill Aqueduct Above City Line 99 Per Cent Completed

THE Catskill Aqueduct for New York City's additional water supply is making very satisfactory progress, practically all of the work being on schedule. North of the city line the aqueduct itself is over 99 per cent completed. The cover is on the Hudson River siphon and water is filling up not only that siphon but also the Moodna and Breakneck siphons. Work around the Ashokan reservoir is progressing well, though it will require all of this season and part of next to complete some of the smaller dikes. The work at the Kensico reservoir is 45 per cent completed and at the Hill View reservoir 80.5 per cent.

On some of the contracts there have been slight extensions, but solely for the work of finishing—such as sodding and seeding slopes, etc. The pressure tunnel under Manhattan Island has, as already noted in this journal, been holed through and the lining is about two-thirds completed. The Silver Lake reservoir on Staten Island is well started and the contract for the Narrows siphon has been awarded.

Speeds of Trains on Curves and Turnouts

Discussion of Relative Effect of Centrifugal Force on Flat Switches and on Smooth Curves with High-Speed Superelevation

EXCESSIVE speed was blamed for the two crossover wrecks on the New York, New Haven & Hartford Railroad some time ago. Much public criticism resulted of the short crossovers used, and the substitution of much longer ones was ordered. That a level turnout of any length is by no means safe for the same speed as a smooth curve of the same degree, properly superelevated, is universally recognized by railroad engineers. Perhaps not many of them, however, have arrived at any means of scientific comparison between the two. Hence the following abstract of a report on the subject presented this week at the convention of the American Railway Engineering Association by the committee on track should be of interest. The investigation and report were prepared by a special subcommittee, consisting of F. S. Stevens, engineer maintenance of way of the Philadelphia & Reading Railroad, and G. J. Ray, chief engineer of the Delaware, Lackawanna & Western Railroad.

Application of Force on Curves

The relation of speed to point of intersection of resultant of forces with plane of track may be derived from the formulæ $W = Mg$ and $C = Mv^2/R$, where M = mass of body, g = acceleration of gravity, W = weight of the body, R = radius of rotation, v = velocity in feet per second and C = centrifugal force. Combining these equations,

$$C/W = v^2/Rg \qquad (1)$$

Let V = velocity in miles per hour and D = degree of curve. Then

$$v = 5280\,V/3600$$
$$R = 5730/D \text{ (approximately)}$$
$$g = 32.16$$

Substituting these values in equation (1)

$$C/W = 0.00001167\,DV^2 \qquad (2)$$

In Fig. 1 let G = gage of track, E = elevation for curvature, H = height of center of gravity above top of rail, F = resultant of forces, A = distance from center of track to intersection of F with plane of track, B = distance from center of gravity to axis of track, x = cant of track = angle of axis of track with the vertical, and y = angle of resultant of forces with axis of track. From the right triangles

$$\sin x = E/G \qquad (3)$$

$$\tan y = (A - B)/H \qquad (4)$$

$$\tan (x + y) = C/W = 0.00001167\,DV^2 \qquad (5)$$

In using the above formulæ we not only need to know the values of H and B, but should also give consideration as to the proper value to assign to G.

Heights of centers of gravity of recently constructed locomotives and tenders, furnished by the Baldwin and American companies, show a range of from 56 to 84 in. for the locomotives in working order and 55 to 76½ in. for the loaded tenders. Hence 84 in., the maximum, is taken as the worst case.

Lateral Play of Engine

The engine has a lateral swing or play due to compression of springs, play on axle, difference between gage of wheels and track, worn flanges, worn rail and widening of gage of track on curves, although the last factor is usually more than neutralized by the distance the center of the wheel base is held away from the outer rail by curvature. It has been assumed that this distance is not less than the middle ordinate of a curve whose chord equals the length of the wheel base.

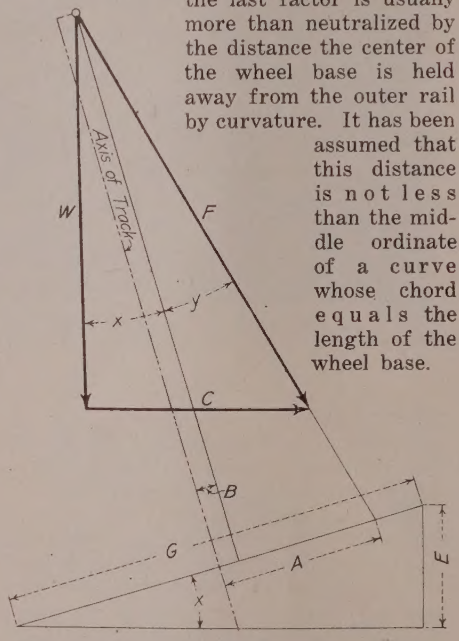


Fig. 1—Diagram of Track and Train Load

As to compression of springs, the upper part of the engine revolves about a horizontal central axis about 40 in. above the rail; the maximum vertical movement of the springs from normal position is about ¼ in., at a distance of about 2 ft. 4 in. from the center of the engine; the resulting swing from one side to the other of a point in the vertical axis of the engine, 84 in. above the rail, is $2 \times (84 - 40)/28 \times \frac{1}{4}$ in. = 11/14 in. or 13/16 in.

Gage of wheels, back to back of flanges, is 53⅜ in. Adding 2 in. for two flanges of minimum thickness gives a minimum gage of wheels, front to front of flanges, of 55⅜ in. Subtracting this from gage of track, 56½ in., maximum play between worn wheels and standard-gage track is seen to be 1⅛ in. Play on axle may be figured as ⅝ in. Summing up these three items we have

Swing due to compression of springs....	13/16 in.
Maximum play between worn wheels and standard-gage track	1⅛ in.
Play on axle	⅝ in.
Total lateral play not affected by degree of curve......................	2 9/16 in.

The Distance *B*

The distance B equals one-half of 2 9/16 in., plus half the widening of gage due to worn rail, plus half the widening of gage for curvature, less the middle ordinate of the curve for a length equal to the wheel base. Working this out for curves of various degrees with a 12-ft. wheel base, it is found that B varies from a possible value of .1½ in. for a 1-deg. curve to a possible 1 7/32 in. for an 8-deg. curve, remains constant, on account of widening of gage for curvature, up to 15 deg. and then decreases. As high speeds are necessarily encountered on the lighter curves and lower speeds on the sharper curves, any change in the assumed value of B would cause a considerable change in the results of calculations of speeds for the lighter curves, but would have a comparatively slight effect on the results for the sharper curves. Hence no great error will result, and such errors as do result will be on the safe side, if the maximum value of B is used throughout.

The value of G may also vary from 56½ in., the standard gage, to 57½ in., but under the conditions which will give B its maximum values G will have values of 57 in. when D is from 1 to 8 deg., and 57½ in. when D is 15 deg. or more. Hence it has been assumed in the calculations that B = 1½ in. and G = 57 in.

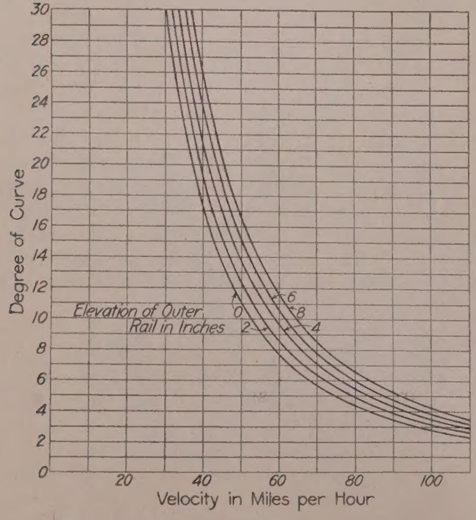


Fig. 2—Resultant through Gage Line

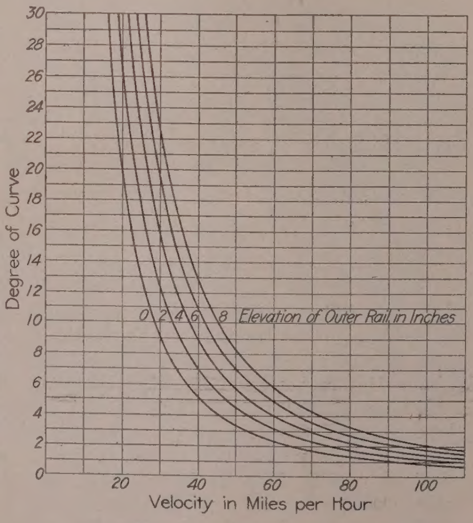


Fig. 3—Through Edge of Middle Third

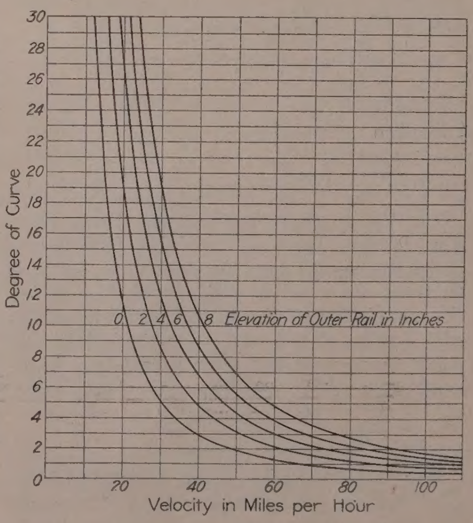


Fig. 4—Three-Inch Unbalanced Elevation

To ascertain the speed which will cause the resultant of force to intersect the plane of the track at any given point k, x may be obtained from equation (3), y from equation (4) and V from equation (5). Figs. 2 and 3 show overturning speeds and speeds which will bring the resultant force through the edge of the middle third for various degrees of curvature and amounts of superelevation.

UNBALANCED ELEVATION

The comfort of a passenger on a train which takes a curve or a turnout at high speed is not dependent on the height of the center of gravity of the engine which draws his train, or of the car in which he is riding, nor is it dependent on the point where the resultant of forces intersects the plane of the track. It is, however, much affected by the condition of the track in the matter of surface and line, and the disturbed equilibrium of the passenger due to centrifugal force uncompensated by the cant of the track. The relation of speed to the condition of the track cannot be reduced to formula, table or diagram, but the relation of equilibrium to speed can very readily be shown. There are many opinions as to what constitutes a comfortable speed on curves; but by tabulating speeds which will produce a certain fixed degree of disturbance of equilibrium we can at least furnish a basis for comparison between speed and comfortable riding.

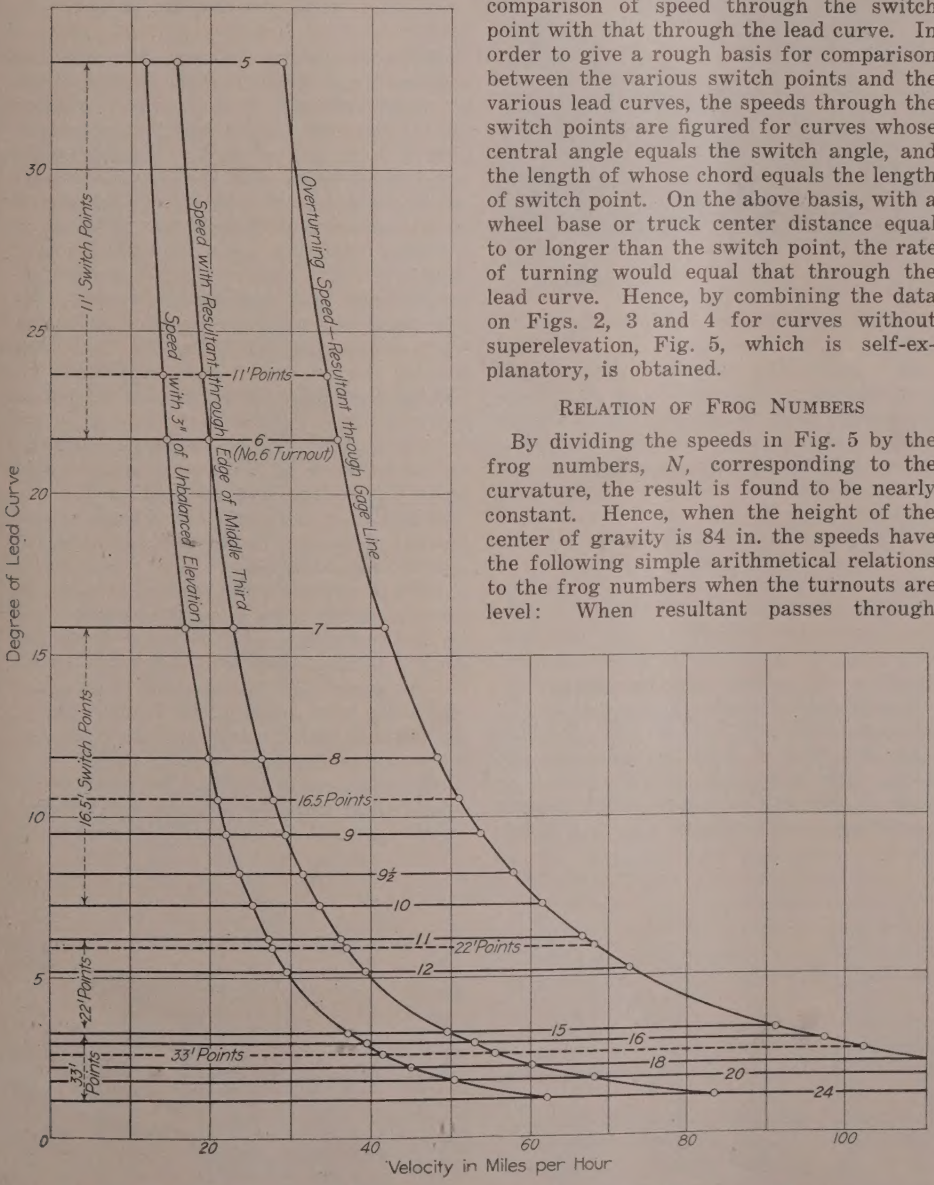


Fig. 5—Speeds through Level Turnouts—84-Inch Height of Center of Gravity

Referring to Fig. 1, if $y = 3$ deg., the track will lack sufficient cant to neutralize the centrifugal force by 3 deg. A difference of 3 deg. in the cant of the track is very closely equivalent to a difference of 3 in. in elevation of the outer rail. Hence, if the amount of discomfort can be measured by the degree of angle which the resultant of forces makes with the axis of the car, it can be measured by the number of inches of unbalanced elevation. In other words, a passenger riding over track elevated 1 in. at a speed requiring an elevation of 4 in. should experience the same amount of discomfort as when riding over track elevated 7 in. at a speed requiring an elevation of 10 in.

Fig. 4 shows speeds which correspond to unbalanced elevations of 3 in. The calculations were made from the formulæ

$$\sin (x + y) = (E + 3)/56.5$$

and

$$V = \sqrt{\frac{\tan (x + y)}{0.00001167\,D}}$$

where E = actual elevation in inches for curvature.

The motion through a straight switch point being angular, there can be no direct comparison of speed through the switch point with that through the lead curve. In order to give a rough basis for comparison between the various switch points and the various lead curves, the speeds through the switch points are figured for curves whose central angle equals the switch angle, and the length of whose chord equals the length of switch point. On the above basis, with a wheel base or truck center distance equal to or longer than the switch point, the rate of turning would equal that through the lead curve. Hence, by combining the data on Figs. 2, 3 and 4 for curves without superelevation, Fig. 5, which is self-explanatory, is obtained.

RELATION OF FROG NUMBERS

By dividing the speeds in Fig. 5 by the frog numbers, N, corresponding to the curvature, the result is found to be nearly constant. Hence, when the height of the center of gravity is 84 in. the speeds have the following simple arithmetical relations to the frog numbers when the turnouts are level: When resultant passes through gage line, $V = 6.1\,N \pm$; when resultant passes through edge of middle third, $V = 3.3\,N \pm$, and when there is unbalanced elevation of 3 in., $V = 2.46\,N \pm$. Other equally simple relations can be figured for other heights of center of gravity. The speed for 3 in. of unbalanced elevation is not affected by height of center of gravity.

SWITCH POINTS

As nearly as can be compared (by assuming the switch point as a chord of a curve whose central angle equals the switch angle) the corresponding speeds through the switches are $3.1\,S$, $1.69\,S$ and $1.26\,S$ respectively, in which S is length of switch point. On such an assumption the length of the switch point should approximate double the frog number, as previously reported by the committee.

The assumption, for the purpose of comparison, that a switch point is equivalent to a curve of equal length subtending an angle equal to the switch angle is, the committee admits, a purely arbitrary one; it would be true only if the curve were exceedingly kinky and consisted of short tangents, whose lengths equaled the lengths of switch point. The reactions at the switch point are rather complex, consisting of both static and dynamic forces. The committee derives a formula for the static thrust, T, which it finds to be approximately $0.14\,W$, varying with the type of engine, but never exceeding $0.19\,W$, where W = weight on drivers. The dynamic force due to impact of engine against the stock rail or switch point is being studied and will be the subject of a future report.

Railroad Expenses and Revenues

GROSS operating revenues on the large railroads of the United States for the last six months of 1913 were $1,611,440,905.35, as compared with $1,606,940,326.56 for the corresponding period in 1912, showing an increase of $4,500,578.79, according to a bulletin issued by the Interstate Commerce Commission. Operating expenses for the same periods were respectively $1,116,666,087.21 and $1,054,468,267.01, which means an increase of $62,197,820.20. Net operating revenues were, therefore, $494,774,818.14 and $552,472,059.55 respectively, showing a decrease of $57,697,241.41. The operating ratio increased from 65.62 to 69.30 per cent. The loss of revenue was borne entirely by the roads in the Eastern and Western districts, as those in the Southern district show a slight gain.

For the months from July to October inclusive the roads throughout the country gained about $25,000,000 in gross revenue over the corresponding period for 1912. There was, however, a decided falling off in November and December as compared with November and December, 1912. Operating expenses were more for each month of the six than for the corresponding month a year previous.

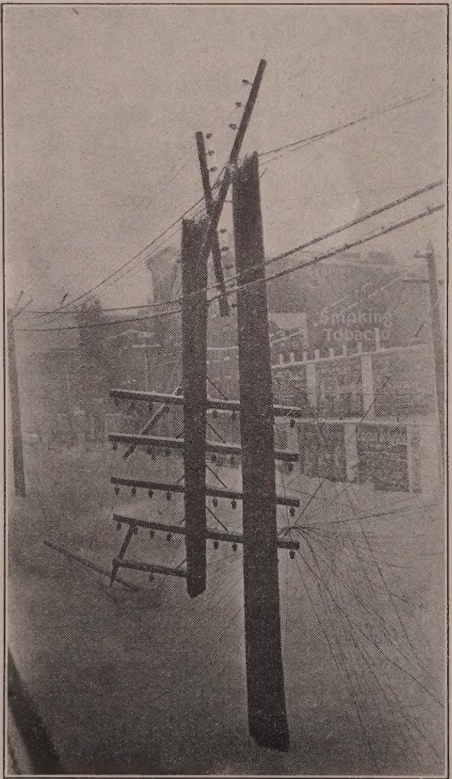
In diagrams prepared by the Bureau of Railway Economics the returns for the entire year are reduced to a per-mile basis and compared with those of 1912. Although gross revenues increased from $13,238 to $13,723 per mile, expenses increased from $9,103 to $9,771 and net revenues decreased from $4,135 to $3,952. The monthly net-revenue curve crossed that of 1912 in June, and has been well below it ever since.

Reinforced-Concrete Poles Withstand Blizzard

Heavy Snow and Sleet Storm in Vicinity of New York Breaks Wooden Poles and Interrupts Telephone and Telegraph Communication

REINFORCED-CONCRETE telegraph poles along the Pennsylvania Railroad in the vicinity of the New Jersey entrance to the Hudson tunnels proved during the blizzard of March 2 their superiority over the ordinary kind of wooden poles. The storm center was in and about New York City. The wind blew at a velocity of 80 miles per hour, and there was a heavy fall of snow and sleet. As far as telegraphic communication was concerned, New York was isolated for several days. So severe a load did the ice-coated wires impose upon the concrete poles that the wooden cross-arms on some of them were broken; the poles themselves, however, remained intact. The accompanying photographs show the condition of the reinforced-concrete poles when erected and after the storm. Other photographs show the condition of wooden poles.

The length of the section provided with concrete poles is about 5 miles, and two hundred and two poles were used. The standard spacing is 120 ft., but railway and highway crossings have in places necessitated spans of from 70 to 135 ft. Above ground the poles project from 25 to 50 ft. and their total length varies from 35 to 65 ft. Each pole is designed to carry sixty telegraph wires, two forty-pair telephone cables and one signal control cable. The telegraph wires are seven and eight gage. The cables are thirteen and sixteen-gage insulated wires with lead covering. These wires load each pole with 1268 lb. for the average span of 120 ft. Including cross-arms, insulators, brackets and fittings, this load averages 1500 lb. An extra loading of ice ½ in. thick on the wires and a wind pressure of 8 lb. per square foot on wires and 13 lb. per square foot on poles were added, so that the total vertical loading per pole was assumed to be 7600 lb., together with a horizontal force of 4000 lb. located 1 ft. below the pole top. The accompanying drawing shows the general design of these poles.



Wooden Pole after Blizzard

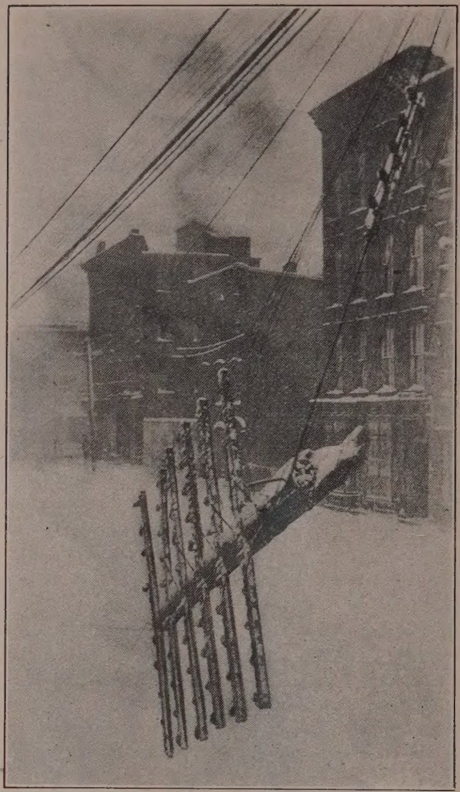
The cost of labor and manufacture of these poles, reduced to a 40-ft. pole weighing 7600 lb., was $19 for forms, $26.50 for concrete and $32 for reinforcement, including the labor. The total cost per pole was $77.50. This sum does not include the cost of the foundations and the setting of the poles, which was considerably more than the cost of the poles themselves.

In spite of this it is estimated that the cost of the line erected complete was not greatly in excess of that of an equally stable wooden pole line.

[Since this article was written the following letter has been received from Charles D. Conklin, Jr., of Cheltenham, Pa.—Editor.]

Concrete Poles after Blizzard

Sir: In passing over the main railroad lines between Philadelphia and New York City shortly after the great storm of March 2 one could not fail to be impressed with the enormity of the damage created by the ravages of the wind and snow. In some of the deeper cuts the light snow had drifted to heights varying from 10 to 25 ft., and it was only at an expense of thousands of dollars that the tracks could be cleared for the passage of trains. This expense, however, was small compared to the loss occasioned by the delay of the passenger and freight traffic between the two cities.



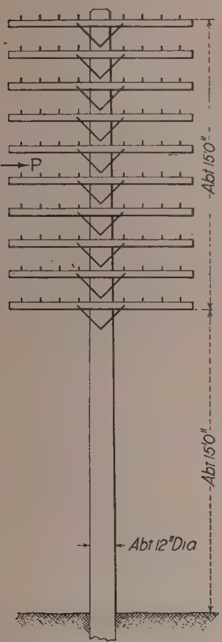
Top of Broken Wooden Pole

Even greater than the loss occasioned by the snow drifts was that caused by the high winds and sleet on the telegraph wires and poles. Mile after mile of telegraph lines down in the drifted snow, poles entirely demolished and the wires in a complete tangle, was a sight sufficient to cause any engineer to wonder whether it would not be more economical to expend greater capital on more substantial first construction of poles and wires which would withstand the elements than to erect cheap, overloaded construction and replace it after such occasional great storms as that of March 2. It seems that the direct incidental losses occasioned by the cheaper construction would more than balance the interest, depreciation, etc., on the first cost of the better equipment. Judging from the fact that some of the larger railroads are already installing steel poles, it seems that the better construction is more economical. An exact comparison, by some of the large railroads, of the economy of the two schemes would prove interesting and instructive.

A lesson on the approximate loads caused by this storm can be learned from the following observed data: The poles for a stretch of several miles seemed to carry an average of ten cross-arms, with eight wires to a cross-arm. The distance from the ground to the lowest arm was about 15 ft., and the arms were spaced about 18 in. apart. The poles were about 12 in. in diameter at the bottom, and the minimum distance center to center of poles was about 50 ft. They were in fair condition, but not new. Practically all of the poles were broken off close to the ground, some with short breaks,

Table of Concrete Poles

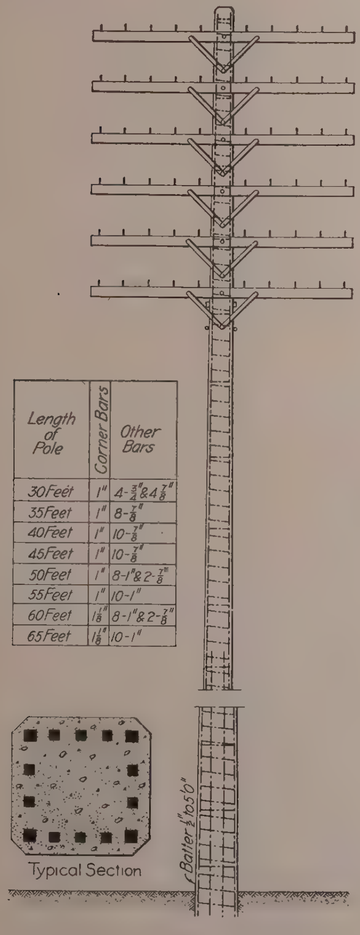
Length, ft.	Equivalent pull 1 ft. from top, lb.	Edge distance for steel, in.	Area steel, sq. in.	Extreme fiber stress in concrete, comp., lb per sq. in.	Unit comp. stress in steel, lb. per sq. in.	Weight of pole, lb.	Concrete, cu. ft.	Weight of steel, lb.	Wire wrapped around pole, lin. ft.
30	4,066	1.75	3.38	1,953	19,059	5,000	33.15	819	228
35	4,321	1.75	3.63	2,087	20,460	6,200	41.44	1,077	273
40	4,505	1.75	4.03	1,817	19,667	7,600	50.75	1,309	333
45	4,647	1.75	4.40	1,987	20,428	9,200	61.56	1,493	375
50	4,763	1.87	4.73	1,886	19,692	11,000	73.24	1,792	431
55	4,860	1.87	5.00	1,832	19,155	13,000	86.58	1,974	490
60	4,945	2.00	5.30	1,812	19,083	15,000	101.28	2,249	553
65	5,020	2.00	5.48	1,976	18,591	17,600	117.23	2,575	618



Typical Wooden Pole

others with long, fibrous breaks. A few poles were broken off near the top. It was evident that the breaks were principally caused by the flexural stress due to the wind blowing on the iced wires, the poles falling in the direction of the wind, over the tracks.

Assuming that each wire was coated so that it formed an ice rope 2 in. in diameter, the weight of each foot would be about 1.4 lb. Eighty of these wires, each 50 ft. long, would bring a load of 5600 lb. direct compression to each pole, or a unit compressive stress of about 50 lb. per square inch. The wind in the storm center was blowing about 80 miles per hour, which produces a pressure of about 26 lb. per square foot on a vertical surface. The moment due to this wind load on a pole 30 ft. high (assuming the wind blowing on a surface equal to the height times one-half the diameter) is 70,200 in.-lb., producing a unit stress on extreme fiber of $(70{,}200 \times 32)$ $(\pi \times 12^3) =$ 413.8 lb. per square inch. The total stress on extreme fiber due to above loads is 463.8 lb., or, say, 500 lb. per square inch.



Length of Pole	Corner Bars	Other Bars
30 Feet	1"	4-$\frac{3}{4}$"&4 $\frac{7}{8}$"
35 Feet	1"	8-$\frac{7}{8}$"
40 Feet	1"	10-$\frac{7}{8}$"
45 Feet	1"	10-$\frac{7}{8}$"
50 Feet	1"	8-1"&2-$\frac{7}{8}$"
55 Feet	1"	10-1"
60 Feet	1$\frac{1}{8}$"	8-1"&2-$\frac{7}{8}$"
65 Feet	1$\frac{1}{8}$"	10-1"

Pennsylvania Railroad Standard Pole

A fair value of the modulus of rupture for the timber in these poles, allowing for knots and other defects and decreased strength due to age, would seem to be about 5000 lb. per square inch. Deducting the 500 lb. caused by the above loads there remains about 4500 lb. per square inch as the stress produced by the wind action on the iced wires.

The total horizontal wind force on the wires acts about 22½ ft. from the ground. If this force be represented by P, then the moment is $P \times 22\frac{1}{2} \times 12$ in.-lb. Then $P = (4500 \times \pi \times 12^3)/(22.5 \times 12 \times 32) =$ 2828 lb.

This is the approximate horizontal force caused by the wind on about eighty wires each 50 ft. long, or about 0.7 lb. per linear foot of wire. Of course, the data are approximate, but they seem to give an idea as to what the probable forces were in this recent severe storm.

Telegraph and Telephone Wires on Reinforced-Concrete Poles along Pennsylvania Railroad

Waterproofing Masonry

Recommendations of Committee of American Railway Engineering Association after Five Years of Investigation

A COMPREHENSIVE report of forty-eight pages on waterproofing masonry, the results of five years of investigation, was submitted this week at the annual meeting of the American Railway Engineering Association by the committee on masonry. The committee discusses coatings, membranes, integrals and watertight concrete construction, and includes five pages of diagrams showing methods of waterproofing bridge floors of various types, arches, subways, expansion joints, etc. The following conclusions are recommended for adoption in the "Manual":

1. Watertight concrete may be obtained by proper design, reinforcing the concrete against cracks due to expansion and contraction, using the proper proportions of cement and graded aggregates to secure the filling of voids and employing proper workmanship and close supervision.

2. Membrane waterproofing, of either asphalt or pure coal-tar pitch in connection with felts and burlaps, with proper number of layers, good materials and workmanship and good working conditions, is recommended as good practice for waterproofing masonry, concrete and bridge floors.

3. Permanent and direct drainage of bridge floors is essential to secure good results in waterproofing.

4. Integral methods of waterproofing concrete have given some good results. Special care is required to proportion the concrete properly, mix thoroughly and deposit properly so as to have the void-filling compounds do the required duty; if this is neglected, the value of the compounds is lost and their waterproofing effect destroyed. Careful tests should be made to ascertain the proper proportions and effectiveness of such compounds.

Integral compounds should be used with caution, their chemical action on the concrete being ascertained as well as their effect on its strength. As a general rule, integral compounds are not recommended, since the same results as to watertightness can be obtained by adding a small percentage of cement and properly grading the aggregate.

5. Surface coatings, such as cement mortar, asphalt or bituminous mastic, if properly applied to masonry reinforced against cracks produced by settlement, expansion and contraction, may be successfully used for waterproofing arches, abutments, retaining walls, reservoirs and similar structures; for important work under high pressure of water these cannot be recommended for all conditions.

6. Surface brush coatings, such as oil paints and varnishes, are not considered reliable or lasting for waterproofing of masonry.

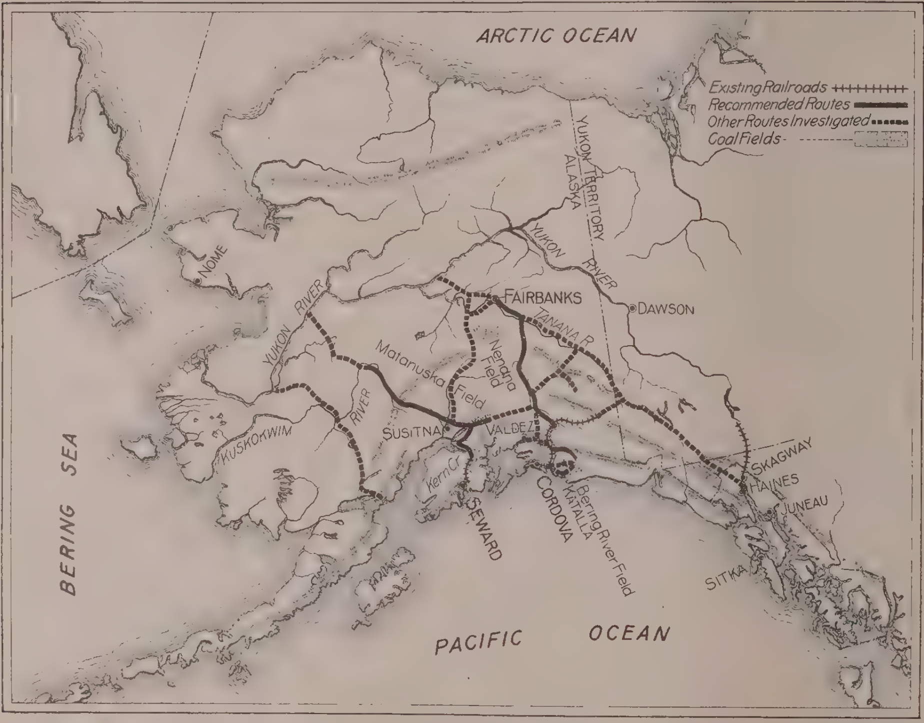
CHEAPNESS of haul on inland deep waterways is shown by the fact that $1 will pay for carrying 1 ton 15 miles on a wagon road, 300 miles on a railroad and 1500 miles on inland deep waterways. The corresponding figure for the ocean is from 2000 to 3000 miles.

Government Railroads for Alaska

Bill Is Passed to Build 1000 Miles or Less, at a Cost of Not More Than $35,000,000, to Develop the Territory's Resources

CONGRESS has agreed in the matter of the Alaska railroad bill, the Senate confrères yielding to the House in the maximum amount of money to be spent and the means of raising it, and both Houses accepting the conference report. The President has signed the bill.

The bill authorizes the President to designate and cause to be located one or more railroad lines from open Pacific harbors on the southern coast of Alaska to navigable waters in the interior and to one or more coal fields. The lines are to aggregate not more than 1000 miles and cost not more than $35,000,000. No provision is made for a bond issue, but an initial appropriation of $1,000,000 is made, to be available until spent. All moneys above maintenance and operating expenses derived from the disposal of land, coal, minerals or timber or from earnings of railroads, telegraph lines or telephone lines are to be paid into the U. S. Treasury, and a separate account of them is to be made and reported annually. Existing utilities may be leased or bought outright at figures not in excess of the actual physical values.



Existing Railroads and Recommended Government Routes in Alaska

REPORT OF COMMISSION

It may be expected that the construction work will conform closely to the recommendations in the report submitted a year ago by the Alaska Railroad Commission, consisting of Maj. Jay J. Morrow, Corps of Engineers, U. S. A.; Alfred H. Brooks, of the U. S. Geological Survey; Civil Engineer Leonard M. Cox, U. S. Navy, and Colin M. Ingersoll, consulting engineer. This commission, appointed in August, 1912, went to Alaska in September and spent fifty-five days on the ground, studying the harbors, the topography and the existing railroad facilities, supplementing personal observations with information obtained from local records and from engineers.

The accompanying map shows the location of the principal rivers and coal fields, the existing railroads, the routes for which estimates were made and those which the committee recommends. The routes proposed and the estimated costs are as follows: Chitina to Fairbanks, 313 miles, $13,971,000; Bering River coal branch, 38 miles, $2,054,000; Kern Creek to Susitna Valley, 115 miles, $5,209,500; Matanuska coal branch, 38 miles, $1,616,000; Susitna Valley to Kuskokwim, 229 miles, $12,760,500.

COMPARISON OF ROUTES

The first-named and largest of these lines is one of several investigated having Fairbanks for their objective. The longest of these, from Haines to Fairbanks, would be 638 miles and would cost $28,000,000, according to the meager data available to the commission. It would not reach any coal fields. That from Valdez would be much shorter, but would also fail to reach any coal fields, as a branch to the Matanuska field from the east would involve heavy grades. From Seward the existing line to Kern Creek could be extended to Fairbanks with a short branch to the Matanuska field. It would require 391 miles of new construction, however, and cost $17,708,000; while the line from Chitina, connecting by the existing line with the port of Cordova, would, as previously stated, be only 313 miles long and cost only $13,971,000. Moreover, a branch to the Bering River coal fields would be preferable to the line from Katalla, because Katalla lacks a good harbor. Cordova, the commission thinks, has the best harbor available. The Cordova route to Fairbanks would also be the cheapest to operate.

For these reasons the commission favors the line from Cordova to Fairbanks to reach the tributary waters of the Yukon and the branch from the existing railroad to the Bering River coal field. It would, however, leave a large and important part of Alaska unprovided for. To obviate this the commission would extend the existing Seward-Kern Creek line to the Susitna Valley as soon as possible, and ultimately to the Kuskokwim. The commission would also build the branch to the Matanuska coal field to make this coal available for local use, even though not in a position to compete with the Bering River coal for outside shipments.

The commission believes that the two railway systems which it thus recommends would at once advance development in the territory and result in the need for many branches. The report concludes with the statement that the commission "is unanimously of opinion that this development should be undertaken at once and prosecuted with vigor; that it cannot be accomplished without providing the railroads herein recommended under some system which will insure low transportation charges and the consequent rapid settlement of this new land and the utilization of its great resources."

Broken Main Depletes Waltham's Water Supply

A BREAK in a 20-in. cast-iron force main, necessitating repair work while the thermometer registered 6 deg. below zero, exhausted the water supply of Waltham, Mass., on Feb. 21. According to information received from Superintendent Daniel J. Higgins, the break occurred in a length of 20-in. English pipe bought and laid in 1907. This break is the third in a section of 2400 ft. of force main. There are about 4000 ft. of American pipe on the same main which has given no trouble. After making an examination of the conduit Mr. Higgins discovered that it was broken from end to end in a 12-ft. length, the crack measuring from ¼ to ½ in. in width. After breaking down the pipe, there was found on the inside, near the bell end, a place as large as a man's hand in the form of a blister. After removing the blister, the iron showed what is called "cold shut" in foundry terms. The iron at this point was about ½ in. thick. The shell thickness was about ¾ in. as compared with the New England Waterworks Association Class E standard specifications of 0.85 in.

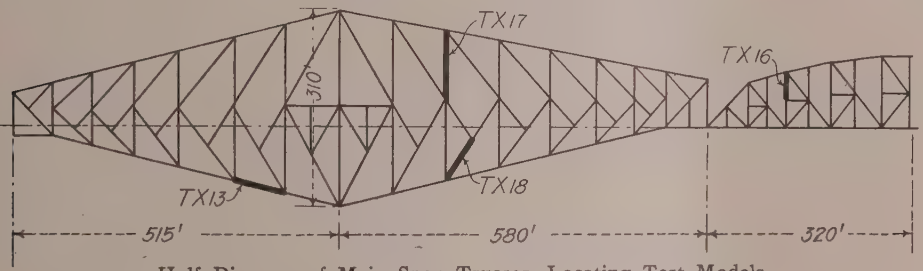
A chemical analysis of the pipe showed the following results: Silicon, 2.72 per cent.; sulphur, 0.072 per cent; manganese, 0.43 per cent; phosphorus, 1.23 per cent; combined carbon, 0.37 per cent; and graphitic carbon, 2.95 per cent. It is evident, Mr. Higgins reports, that the silicon and phosphorus are so high that the pipe is very brittle and not at all to be trusted. The need of a secondary supply was felt during the recent water famine and arrangements have now been made whereby Waltham may connect with the city of Newton.

DITCH cleaning by sheep to eradicate Johnson grass met with such success last season on the Salt River project of the U. S. Reclamation Service that 2000 head have been purchased by the Water Users' Association, according to the "Reclamation Record." When Johnson grass goes to seed it is likely to spread to cultivated fields. Four flocks of sheep will be used in the ditch-cleaning process. The experiments made so far show that the cost of cleaning is reduced, the sheep fatten and may be sold at a profit, the increase pays the expense of care, and the obnoxious grass is so weakened by the close cropping as to promise thorough eradication in two seasons' treatment.

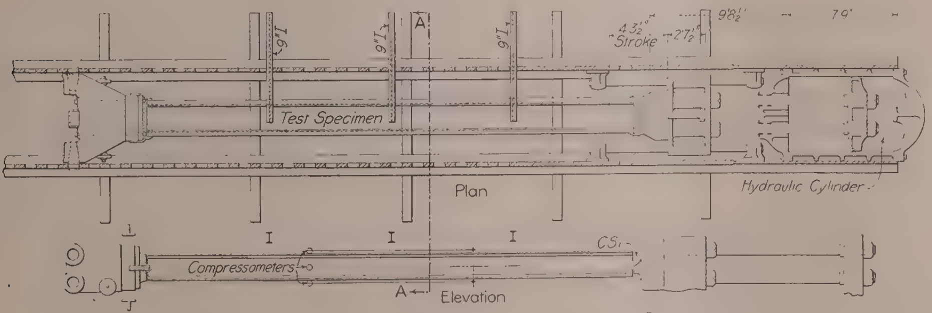
Ultimate Strength of Carbon and Nickel-Steel Models of Quebec Bridge Members

Destruction Tests of Precision on Large Riveted Compression Members in the 640-Foot Suspended Center Span

A SERIES of eighteen destruction tests of large-size models of tension and compression members for the trusses of the 1800-ft. cantilever span of the new Quebec Bridge has recently been made at the Phoenix Bridge Company's shop. The specimens were larger and stronger than similar members in many important railroad spans, and the results were carefully and accurately observed and recorded in great detail in order to furnish data for the analysis of the type of design, the character of detailing, fabrication and construction, the ultimate efficiency of the members, and especially for the comparative working value of duplicate compression members made of carbon or of nickel steel. A significant result is the demonstration of an elastic limit of a carbon-steel riveted compression member varying from 50 to 63 per cent of the elastic limit of a duplicate member made of nickel steel. The tests are also illuminating in their bearing on late developments of design for important tension and compression members.



Half Diagram of Main Span Trusses, Locating Test Models

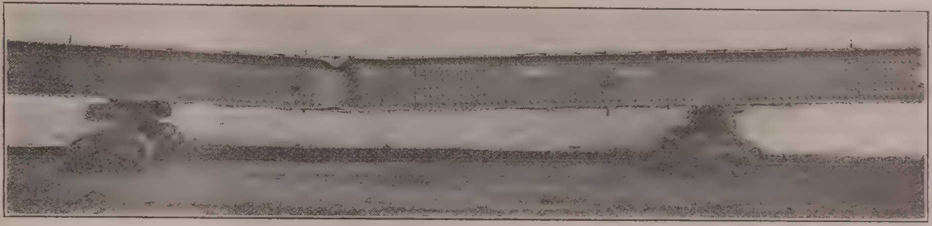


Position of Model and Counterbalance Levers in Testing Machine

SCOPE OF TESTS

The tests involved maximum loads of 2,800,000 lb. and included four tension tests on riveted plates, two tension tests on riveted members with rectangular cross-sections calculated to receive either tension or compression, and twelve compression tests on members made with two or more web plates and latticed flanges, models of compression members in the webs and chords of the cantilever trusses. The tests of two nickel steel and of two duplicate carbon-steel compression members showed the highest ultimate strength of the nickel-steel members to be about 54 per cent greater than that of the weakest carbon-steel member and its elastic limit 101 per cent greater than that of the weakest carbon-steel member.

The compression tests in this series were made on models of the vertical and inclined web members and of the inclined bottom chords of the cantilever and anchor arms and suspended truss. The models have maximum cross-sectional areas of 70.65 sq. in. and maximum lengths of 45 ft. 10 in. The nickel-steel models have a cross-sectional area of 35.2 sq. in. and a length of 34 ft. Some of the models represent members having shop weights up to 140 tons and lengths up to 90 ft.



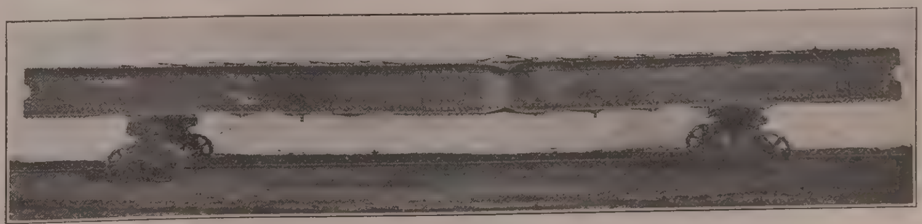
Model TX16N—1 After Compression to Destruction

The design of the old bridge was fully described and illustrated in many articles published in the Engineering Record and in the report of the Royal Commission, which was published in full in the Engineering Record of March 14, 1908, page 309. In connection with the official design for the new bridge prepared by the board of engineers, a number of models of its principal truss members were made in carbon steel to a scale of about one-fourth the natural size and were tested to destruction by the Phoenix Bridge Company in the same machine which was used for the tests described in this article, giving results interesting for comparison of strength and efficiency of material and design. The largest of the sixteen models had a cross-sectional area of 57.1 sq. in. and a length of 35 ft. 9 in., and the highest elastic limit obtained was 36,618 lb. per square inch. The details of these tests were published in the Engineering Record of Nov. 19, 1910.

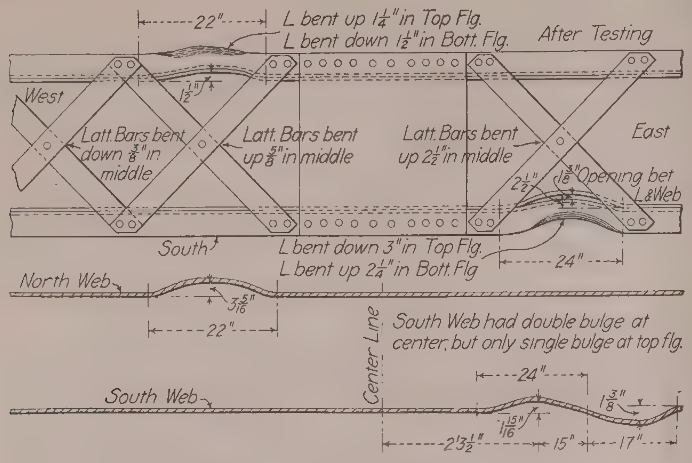
All of the models in both series were tested at Phoenixville, Pa., in the Phoenix Iron Company's machine which was built by them from their own design and has recently been overhauled, calibrated and standardized and the frictional correction determined, which has been applied wherever necessary to the results recorded for these tests. The machine is of a horizontal hydraulic type, giving direct stress up to a nominal capacity of 2,720,000 lb. tension or compression, and can receive members up to 50 ft. long for compression and about 40 ft. long for tension, dependent upon elongation of metal. It has a plunger area of 3000 sq. in. and stroke of about 6 ft. The cylinder head is permanently attached to the plate girder bed frame and the movable head can be pin-connected to the frame at any point within the limit of length. Pressure in the hydraulic cylinder has been developed by a direct-acting steam pump, but an electrically operated hydraulic pump is now used. To provide for testing compression members a steel casting with a half hole bearing for a horizontal pin 10 in. in diameter was bolted to the plunger head and split steel bushings were provided for it and for the pin bearing on the movable head to correspond with the sizes of pins in the compression members.

COUNTERBALANCING

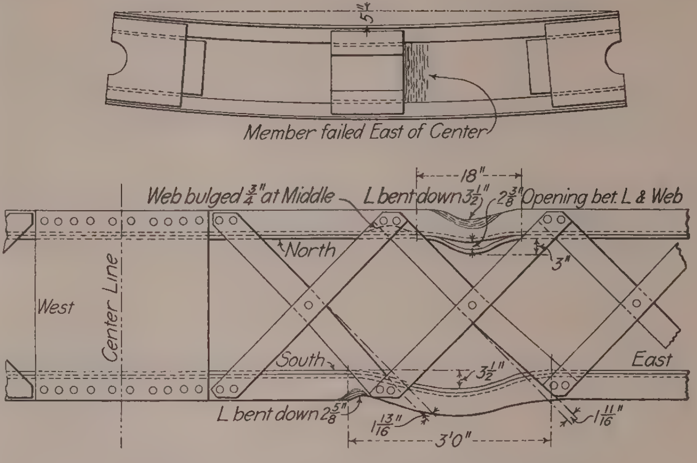
Fulcrums consisting of steel pins in wooden half hole bearings with clearance between them were set on the bed of the machine at three equidistant points intermediate between the fixed and movable heads, and supported horizontal I-beams transverse to the axis of the machine at their center points. One end of each I-beam projected across the compression specimen test and was attached to it by a bridle or sling inclosing the piece. From the other end of the beam was suspended a weight corresponding to the fraction of the weight of the truss member which it was intended to counterbalance, thus relieving the test specimen of secondary stresses due to its own weight.



Model TX16C—1 After Compression to Destruction


22"
L bent up 1¼" in Top Flg.
L bent down 1½" in Bott. Flg.
After Testing
1½"
West
Latt. Bars bent down ⅜" in middle
Latt. Bars bent up ⅝" in middle
Latt. Bars bent up 2½" in middle
East
2½"
1⅜" Opening bet L & Web
South
L bent down 3" in Top Flg.
L bent up 2¼" in Bott. Flg
24"
North Web
3 5/16"
22"
Center Line
South Web had double bulge at center, but only single bulge at top flg.
24"
South Web
1⅜"
1 15/16"
2' 3½"
15"
17"

Model TX16C—1 at Point of Failure, After Test

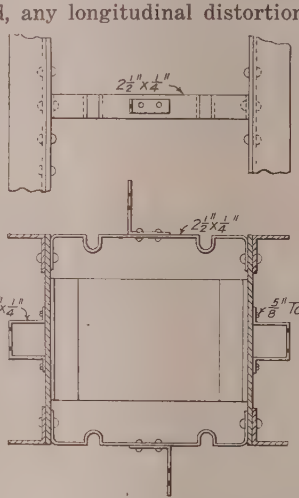


Model TX16N—1 at Point of Failure, After Test

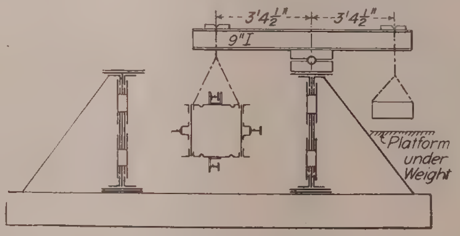
The elongations and compressions on short distances were measured by J. E. Howard for numerous locations near the pin bearings by the use of standard Brown & Sharpe strain gages. Each gage had two conical steel points inserted in special holes of about 1-16 in. in diameter and about 1-16 in. deep, drilled and reamed with precision in the required positions, thus providing for very exact and unvarying setting of the instruments.

Measurements of the elongations and compressions between points a long distance apart, at the center of the model and in its full length were made by C. Scheidl, Jr., of the Phoenix Bridge Company. He used Olsen standard compressometers. Each had a graduated circular dial and an indicator needle having a horizontal axis with friction bearing intermediate between its journals. The friction bearing consisted of a concentric cylinder with a circumference of ½ in., which engaged a long horizontal steel rod fixed at one end to the test specimen at one of the points between which the elongation or compression was to be measured. The rod was supported intermediately on rollers and the other end rested on the friction cylinder and its weight developed sufficient pressure to produce friction revolving the cylinder and the axis of the needle to correspond with any longitudinal movement of the rod.

The bearings of the needle being firmly attached to the specimen at an accurately measured distance from the attachment of the rod, any longitudinal distortion of the model produced a relative movement of the rod on the axis and caused the latter to revolve. The ratio of the diameter of the friction bearing and the diameter of the dial of the machine being 25 and the dial being graduated to five-hundredths, gave a direct reading of 1-1000 in., which could be reduced to 1-10,000 in. by the vernier scale of 1:10.



Attachment of Brackets for Compressometers

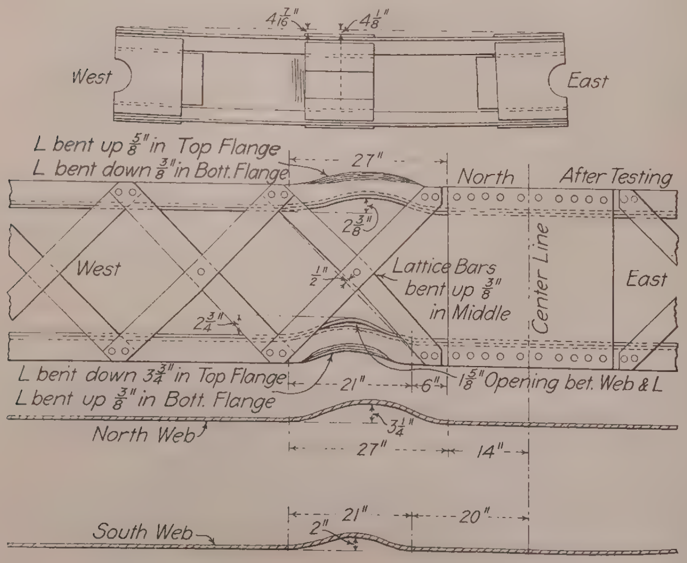


Section A-A

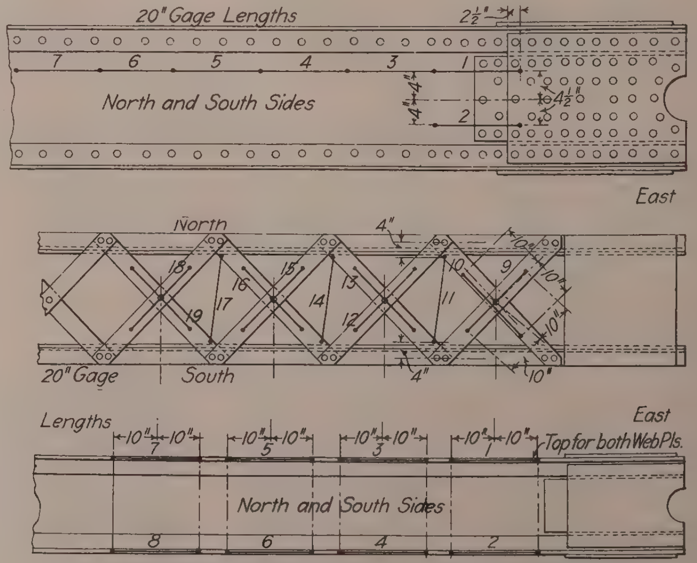
Arrangement of Compressometer Brackets and Counterbalance Levers

Application of Instruments

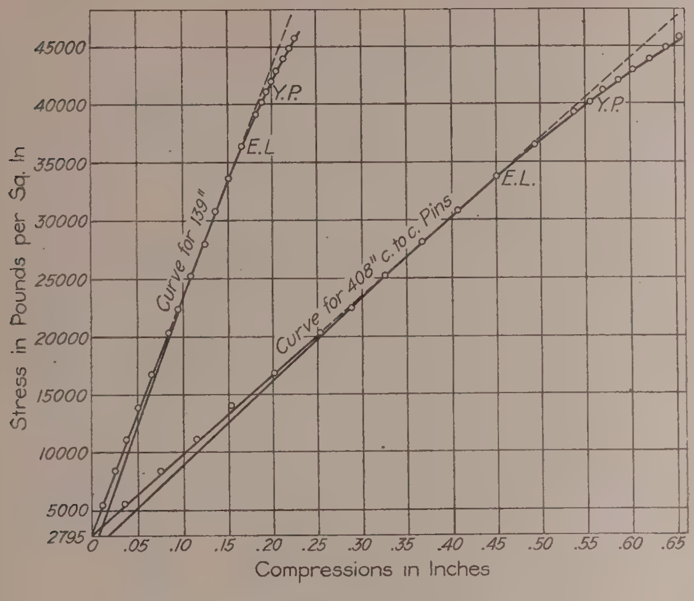
In order to correct eccentricity and irregularity and secure true values of the total distortion of the model a compressometer was applied to each of the four sides of the cross-section and the mean of the results was taken. Each machine was bolted securely to a steel bracket, and the latter was either bolted or riveted to the model. For readings taken on the vertical sides the brackets were riveted to the web plates, but for readings taken on the horizontal latticed faces the brackets could not be attached directly to the lattice bars, because the latter, not being directly affected by the compression in a member, are materially displaced by the compression in the web plates, and since they retain at first their original length while the longitudinal distances between their rivets are diminished, the web plates tend to move farther apart. To avoid errors due to this displacement, transverse expansion clips with compensating loops bent in them were riveted to the webs and the brackets at-


4 7/16"
4⅛"
West
East
L bent up ⅝" in Top Flange
L bent down ⅜" in Bott. Flange
27"
North
After Testing
2⅜"
West
½"
Lattice Bars bent up ⅜" in Middle
Center Line
East
2¾"
L bent down 3¾" in Top Flange
L bent up ⅜" in Bott. Flange
21"
6"
1⅝" Opening bet. Web & L
North Web
3¼"
27"
14"
21"
20"
2"
South Web

Model TX16C—2 at Point of Failure, After Test



Location of Strain Gage Measurements on Models TX16N—1 and TX16N—2



Model TX16N—1

Model TX16C—2

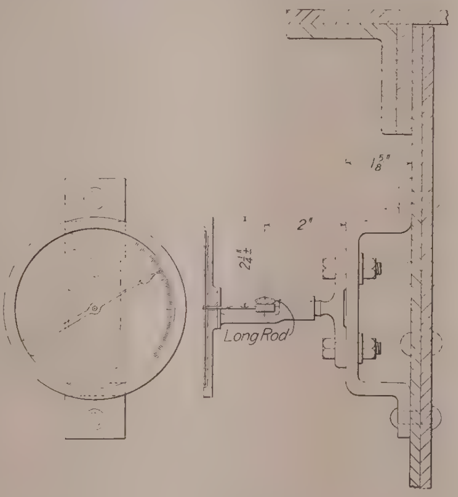
Stress Deformation Diagrams of Phoenix Bridge Company's Readings

tached to them, thus providing against displacement of the instrument by transverse movement of the webs.

Brackets were also riveted to opposite extremities of the model, and to them were attached small sheaves over which a fine steel wire was stretched by a weight, thus providing a straight line from which lateral deflections were measured by scale. To secure greater accuracy and uniformity of observation and avoid danger from possible fracture or movement at the time of destruction of the model, the compressometers were read through small telescopes mounted on standards and located at fixed points from 2 to 6 ft. distant from the specimen.

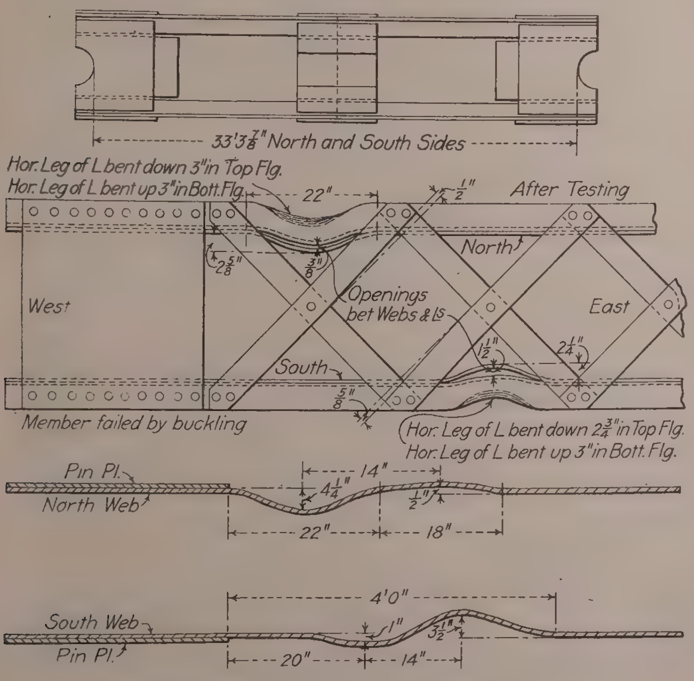
METHOD OF TESTING

The models, which were fabricated by the Pennsylvania Steel Company, were carefully inspected and measured and the cross-sectional areas very carefully determined. Brackets were riveted to them to receive the instruments and the alignment wires, and the necessary holes were drilled to locate and receive the strain gages. The fixed head of the machine was locked in the required position, the bearings, castings and pins were adjusted and the model was delivered to the machine by an overhead crane and was centered and adjusted in exact alignment with the axis of the machine. In some cases the weight of the model was counterbalanced by the cantilever beams already described, and in other cases its weight was not supported between the ends.

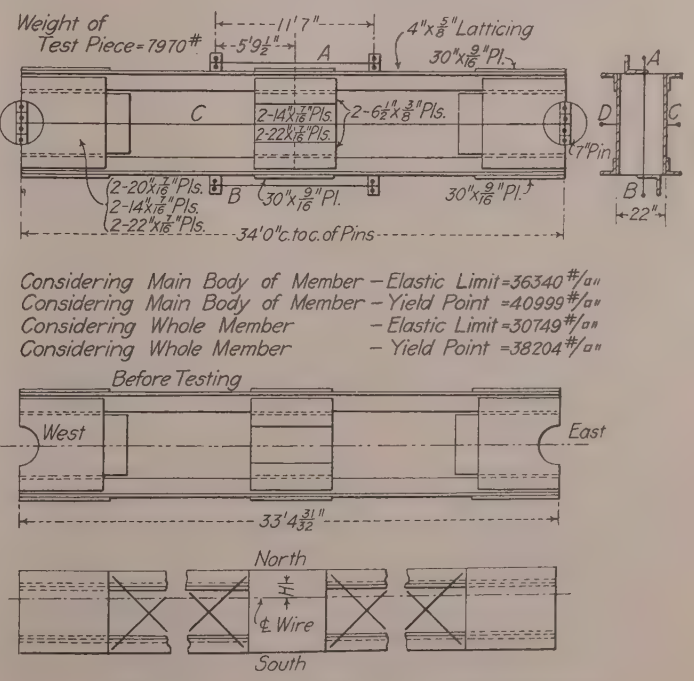


Attachment of Compressometer to Model

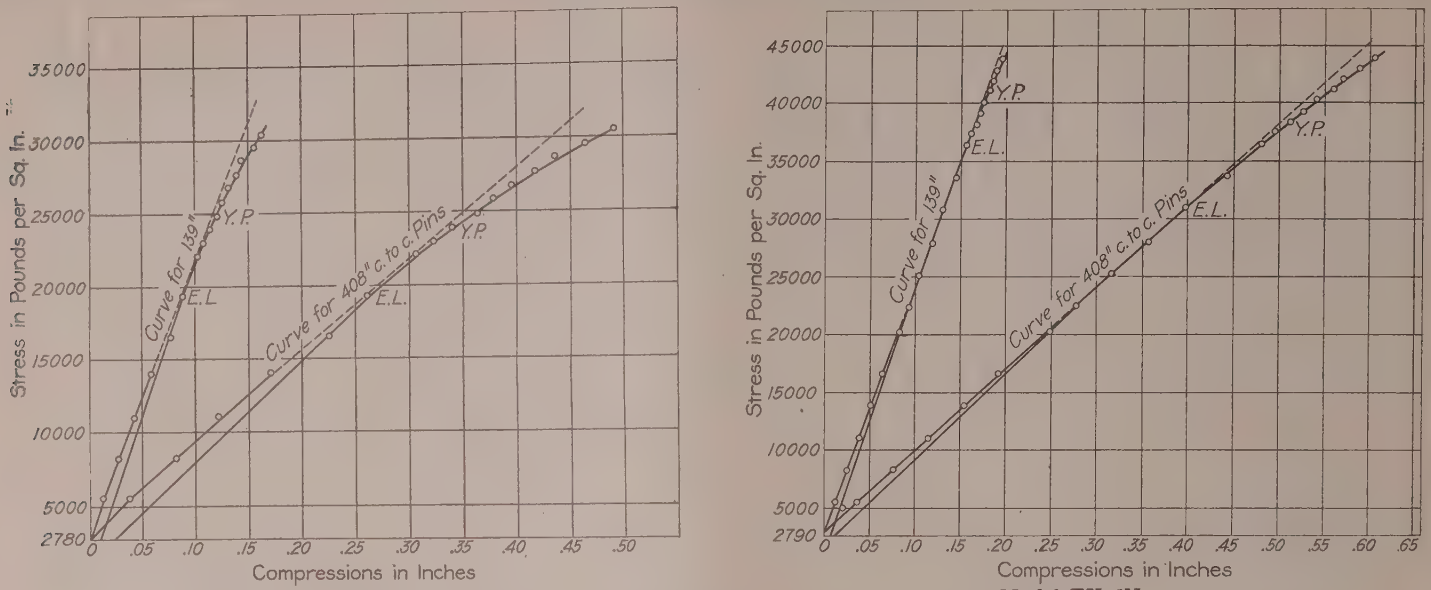
Extreme care was exercised in making the pin bearings as accurate as possible; this was accomplished by a slight adjustment in the head of the machine. Usually one day was required for preparing the machine and making everything ready for the test, after which from one to three hours were necessary for putting the model in the machine, attaching the instruments to it, setting up the telescopes and making ready for the test. The test itself occupied from one to three hours and required four observers, one gageman, two recorders and about six laborers. Before making the test, sheets were prepared giving all the preliminary data, together with the different gage loads which were to be applied with


33'3 7/8" North and South Sides
Hor. Leg of L bent down 3" in Top Flg.
Hor. Leg of L bent up 3" in Bott. Flg.
22"
1/2"
After Testing
North
2 5/8"
3/8"
West
Openings bet Webs & Ls
East
1 1/2"
2 1/4"
South
5/8"
Member failed by buckling
Hor. Leg of L bent down 2 3/4" in Top Flg.
Hor. Leg of L bent up 3" in Bott. Flg.
Pin Pl.
North Web
14"
4 1/4"
1/2"
22"
18"
4'0"
South Web
Pin Pl.
1"
3 1/2"
20"
14"

Model TX16N—2 at Point of Failure, After Test



Models TX16 and Positions of Compressometers



Model TX16C—1

Model TX16N—2

Stress Deformation Diagrams of Phoenix Bridge Company's Readings

the corresponding unit loads and the amounts of distortion which it was expected would result.

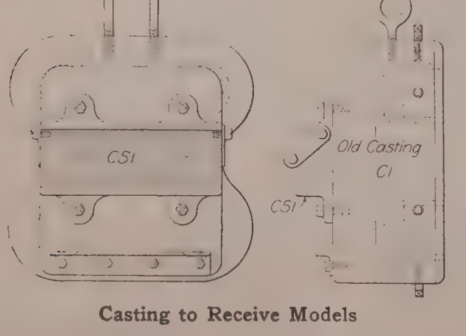
Deformation Diagrams

The diagrams of deformation shown by the compressometers were plotted, giving straight lines from the origins to the elastic-limit points, beyond which they are, of course, broken lines, with the yield points noted at an arbitrary distance from the straight line, thus giving a graphic representation of the distortion of the specimen under stress. In every case the pressure at 26,000 lb. per square inch net for nickel steel, 20,000 lb. gross for nickel steel, and 14,000 lb. gross for carbon steel was released, and as a permanent set had then taken place, the deformation line for succeeding pressures commenced at a point offset from the origin and intersected the first line at the point of elastic limit, thus accounting for the two lines shown in the diagrams.

Tests of Vertical-Post Models

Material	Mark	Elastic limit: At center, lb. per sq. in.	Elastic limit: In full length, lb. per sq. in.	Ultimate load, lb. per sq. in.	Manner of failure	Elevation of center point at commencement of test	Date of test, 1913	Time of test readings, First	Time of test readings, Last
Nickel steel	TX16N-1	36,340	33,545	47,522	Web buckled near center	1/64 in. high	Mar. 3	9.43 a.m.	1.15 p.m.
Nickel steel	TX16N-2	36,340	30,749	51,624	Web buckled at one end	3/32 in. high	Mar. 10	1.25 p.m.	5.33 p.m.
Carbon steel	TX16C-1	19,457	16,667	36,597	Web buckled on opposite sides of center splice	1/16 in. high	Mar. 11	1.13 p.m.	4.46 p.m.
Carbon steel	TX16C-2	19,457	19,457	33,354	Both webs buckled adjacent to center splice	1/16 in. high	Mar. 12	1.09 p.m.	4.49 p.m.

Duplicate nickel and carbon-steel models, TX16, 34 ft. long, made of two built channels latticed, were marked N and C respectively and corresponded to the upper sections of vertical posts in the center suspended span of the new Quebec Bridge. Each of them was spliced at the center, with cover plates on all sides, and had half-hole pin bearings at both ends. The weight was 7970 lb. and the area computed from it was 34.63 sq. in., being 1.61 per cent light of the nominal area of 35.2 sq. in. Each model was counterbalanced in the testing machine by a 1230-lb. weight applied at the center and at each quarter point to eliminate fiber stress due to the weight of the model. The models had a ratio $L/R = 52$. The specimen test results were exactly the same for both nickel and for both carbon steel pieces.



Casting to Receive Models

Strain gages were applied simultaneously to the latticed faces on both sides in nineteen 20-in. spaces on one model, and on both webs, and in eighteen spaces simultaneously on the other model. The compressometer was applied to lengths of 11 ft. 7 in., measured on the latticed faces at the center of the models, and to lengths of 34 ft. measured from center to center of end pins on the web-plate faces. The elastic limit of the body of the member was determined by observations on a short length near the center point, and that of the member as a whole, including its connection details at the ends, was determined by observations on the full length. In each case the initial gage reading was 30.

C. N. Monsarrat is chairman and chief engineer and Ralph Modjeski and C. C. Schneider are the other members of the board of engineers of the Quebec Bridge. The tests were made for the St. Lawrence Bridge Company, of Montreal, contractor for the superstructure of the new Quebec Bridge, by the Phoenix Bridge Company, of which John Sterling Deans is chief engineer, P. L. Szlapka designing engineer, and Charles Scheidl assistant engineer in charge. The tests were made under the direction and personal supervision of James E. Howard, Bureau of Standards, Washington, D. C.

Fire Protection for Standing Timber

FOREST fires totaling 578 in number were recorded in British Columbia during 1913, which is 231 more than were reported in 1912, according to the recently submitted report of Provincial Forester H. R. McMillan. It is not thought that the weather conditions of 1913 were less favorable, but that there was much better organization on the part of the fire patrol, so that a much larger percentage of the fires was reported. This view is borne out by the statistics in the report, which places the total damage caused by fire in 1913 at $18,354, as against $313,273 in 1912. Of this total the loss sustained by standing timber was $4,387, as against $200,000 in 1912. Many of the 1913 fires which were reported and extinguished promptly, Mr. McMillan states, would otherwise have spread slowly or smoldered until favorable weather conditions permitted extensive and serious conflagrations.

The fire-protection staff for 1913 numbered in midsummer about 320 men, or an increase of 50 per cent over the force in the field in 1912. The total area under administration was 150,000,000 acres, or 25,000,000 acres more than the area covered in 1912. The average area assigned to each guard last season was 943,000 acres, although, of course, the men were not distributed mathematically, but according to local conditions of hazard and communication. The season was begun with a permanent staff of about 20 rangers. The regular fire guards and railway patrolmen were put on duty in May, and during the extra dangerous periods of July and August special fire guards were added to the force as required. The total cost of patrol alone was about $190,000, or 12 per cent more than in 1912. This averages about one-eighth of a cent per acre, as against about one-seventh of a cent per acre in 1912. In addition to patrol duty, the forestry department constructed a total of 1200 miles of trails and strung 300 miles of telephone wire before winter set in.

Review of the Work of the American Railway Engineering Association

Summary of the Year's Investigations and Conclusions of the Various Committees as Reported at the Annual Convention This Week

DURING the last year the nineteen standing and two special committees of the American Railway Engineering Association have continued their investigations along the lines assigned. The following account aims to give a brief summary only of their investigations and recommendations. More extended abstracts of some of the studies may be found elsewhere in this issue, or will appear in succeeding issues. Inasmuch as this summary must necessarily go to press before the convention, it is prepared irrespective of the convention's action.

ROADWAY

Three subcommittees divided the work of the committee on roadways. The subcommittee on unit pressures allowable on roadbed of different materials states that nothing further can be done until experiments under actual traffic conditions have been made. A special joint committee of the association and the American Society of Civil Engineers has been appointed and arrangements have been made for a fund sufficient to start the experimental work. In case these funds prove insufficient a nominal assessment on a mileage basis is recommended against the railways represented in the association. Experimental observations by J. R. W. Ambrose and James E. Howard are included as information in the subcommittee's report.

Tunnel construction and ventilation was the subject under investigation by the second subcommittee. Its conclusions include diagrams representing good practice for construction in rock of various degrees of hardness where time is an important element. The third subcommittee, investigating "economics in roadway labor," refers to the work of other committees, and to the arrangement for a subdivision of the study with the committees on track and on signals and interlocking, whereby it was decided that this committee should consider only the question of labor required for construction work. It believes, however, that the conditions under this head are so variable that recommendations would be of little value, and therefore asks to be relieved of further consideration of the subject. It does, however, consider the subject of "economics of railway labor" of enough importance to warrant a special committee to study it.

BALLAST

With a view to revising ballast sections, with particular reference to the use of a sub-ballast and a top ballast, the committee on ballast has assembled standard sections of some of the principal railroads and has prepared a composite drawing therefrom. The committee concludes that ballast should be 24 in. deep, but that where Class A stone ballast is used there may be a sub-ballast of fine material for half the total depth. Drawings of proposed sections for single and double track are presented, and the committee recommends that these sections be put in service for short stretches on some railroad early this year, with a view of obtaining a full report on the process of applying and the results of maintenance for the 1915 convention.

In the study of methods and costs of cleaning stone ballast special attention was given to the use of screens as practised by the Baltimore & Ohio Railroad. Communications from four other Eastern railroads show that they use forks only and are paying approximately double what the Baltimore & Ohio is paying. Changes and additions to the "Manual" recommended by the committee include a statement that tests indicate that stone ballast can be cleaned by the use of screens for approximately half the cost with forks. W. I. Trench, division engineer of the Baltimore & Ohio, whose report last year on the screen method was abstracted in the Engineering Record of April 26, 1913, page 474, amplifies this with a supplementary discussion touching upon the advantages of frequent cleaning, improvements made on the screen since the previous report and the organization of the work. Details are presented of such a screen.

Unsuccessful efforts have been made to finance the test recommended last year to determine the proper depth of ballast of various kinds to insure uniform distribution of loads on the roadway. The committee renews its recommendation that the test be made under traffic conditions, and recommends that several railroads be asked to make such a test at their own expense in the near future.

TIES

No recommendations are made by the committee on ties. Extensive progress reports are offered, however, the reports on three of the four subjects under investigation occupying 133 pages in the "Bulletin." No report is made on the subject of stresses in ties.

Thirty-seven inquiries were sent out to the principal railroads asking information pertaining to tieplates. Twenty-nine replies were received and twenty-seven were in substantial agreement on nine salient points. Three illustrated appendices go extensively into the comparative holding power of spikes—chisel point versus diamond point, and cut spikes versus screw spikes, and the effect of design of spikes and tieplates on the durability of ties.

On the subject of economy in labor and material effected through the use of treated ties compared with those untreated the committee presents data collected from the United States, Canada and Europe. So far as the committee has proceeded the comparison of the cost in labor and material favors the tie which is treated with a preservative that will protect the wood fiber against decay to the limit of wear.

Eighteen pages relative to metal, composite and concrete ties are submitted to be added to previous reports on this subject. Following usual custom, these data are excerpts from communications from officials of railroads that have used the ties, only those ties which have been in actual use by some steam or electric roads being mentioned.

RAIL

As usual, the committee on rail, which is the largest committee in the association, shows great activity during the year, both in the assigned work and in individual investigations. Reports and conclusions have appeared in four different issues of the "Bulletin," some of which have been before the association several months.

Rail-failure statistics for the year ended Oct. 31, 1912, are chronicled in a report of forty-nine pages, nine tables and thirteen diagrams. The committee states that the responses from the railroads have been better during the last year than ever before, but that there is still chance for improvement. The committee recommends for adoption a revised form MW408 for reporting rail failures to replace forms MW408 and 411 and enable the committee more readily to connect up failures with the practice at individual mills.

The committee presents for adoption revised specifications for carbon-steel rails, following a conference with the manufacturers' committee. The principal change is the omission of the clause permitting an increase of carbon for a decrease in phosphorus. The committee states that "the type of rail failure known as a 'transverse fissure' in the head of the rail seems to occur mostly in rails containing more than 0.80 per cent carbon, and it is thought well for the present to keep the maximum carbon limit below this amount in weight of rails covered by these specifications."

The committee feels that the information gained to date in the study of the present A. R. A. standard rail sections, types A and B, is not such as to warrant the recommendation of changes at this time. The question of sections heavier than 100 lb. has been under consideration, but no definite conclusions have been reached.

A circular showing a proposed drilling for four-hole and six-hole splice bars was submitted to representative railroads for criticism. From the information supplied the committee thinks it would be very hard to get all roads to drop their own standards and agree on a single design. The committee thinks, however, that the old standards will ultimately disappear, and favors a uniform spacing of holes of 5½ in. (The spacing recommended by the committee on track in 1904, and afterward withdrawn, was 5 in.) For the 5½-in. spacing the committee states that 24 and 32 in. respectively would be satisfactory lengths for four-hole and six-hole suspended joints.

Five special papers were presented to the committee during the year, and are printed in the "Bulletin." One of these was by H. B. MacFarland, engineer of tests of the Santa Fe system, on "Influence of Seams or Laminations in Base of Rail on Ductility of Metal." The other four were by M. H. Wickhorst, engineer of tests for the committee, on "Influence on Rails of Amount of Draft in Blooming," "Comparison of Basic and Acid Open-Hearth Rails, and Influence of Reheating Cold Bloom," "Seams in Rails as Developed from Cracks in the Ingot" and "Influence of Aluminum and Silicon on Bessemer Ingots and Rails."

TRACK

In addition to the three subjects assigned to the committee on track—main-line turnouts and crossovers, economics of track labor and relation between worn flanges and worn switch points—the committee undertook a study of speeds of trains on curves and the relation between speeds and the bad curves and switch angles of turnouts. Its report on this subject is abstracted elsewhere in this issue. The committee recommends the adoption of the diagrams of speeds of trains through curves and level turnouts, and a table showing relative speeds through level turnouts to give the equivalent riding condition to track elevated 3 in. less than theoretically required.

The committee offers for adoption typical plans of Nos. 8, 11 and 16 crossovers, and points out errors which should be corrected in the dimensions of the No. 15 turnout as given in the "Manual." It also submits as information typical plans of Nos. 8, 11 and 16 double-slip crossings and a progress report on economics of track labor. No conclusion has been reached as to the relation between worn flanges and worn switch points.

BUILDINGS

Continuing the study of the design of freight houses and their floors, the committee on buildings presents a five-page report, to replace the conclusions now in the "Manual," on the principles covering the design of inbound and outbound freight houses and a nine-page report on shop floors, which is intended to supplement the report of last year on freight-house floors. The committee also offers for substitution for the long report on roofing now in the "Manual" a four-page summary.

WOODEN BRIDGES AND TRESTLES

Among other things the committee on wooden bridges and trestles was instructed to report on formulae for sheet piling. The committee undertook some experimental investigations. The equipment first installed proved inadequate, however, and other difficulties that arose made it impossible to report fruitful results this year. It is pointed out that the investigation is closely allied to that of the committee on masonry on the design of retaining walls, and thinks that to avoid duplication of experiment the two investigations should be combined.

Conclusion 2 adopted last year on the use of guard rails is amended to make it consistent with the other recommendations and to provide for beveling or bending down the ends of guard rails to protect them against direct impact with moving parts of equipments. A fifth conclusion is recommended specifying the use of inner guard rails on all open-floor bridges and on the outside tracks of all solid-floor bridges and similar bridges and structures longer than 20 ft. in main-line tracks or in branch-line tracks where a speed of 20 or more miles per hour is allowed. The purport of this recommendation is to provide protection on deck structures as well as on through structures.

The committee reports progress on the subject of economy of repairs and renewals of trestles, but is not ready yet to formulate conclusions.

MASONRY

A final report of forty-eight pages is made by the committee on masonry on the subject of waterproofing masonry and bridge floors. The matter is treated exhaustively and six main conclusions are reached. The committee approves membrane waterproofing as the best, and points to the necessity of direct drainage of bridge floors. A shorter report is also submitted on the general topic of disintegration of concrete and corrosion of reinforcing metal. Four conclusions are reached: (1) That concrete exposed to the action of sea or alkali waters or gases containing sulphur, or in which reinforcing metal is embedded, should be dense and rich in Portland cement and should be allowed to harden under favorable conditions; (2) that concrete in contact with alkali waters should be made with aggregates inert to the alkalies in the water; (3) that cinders should not be used for concrete in which reinforcing metal is embedded, and (4) that reinforcing metal should not be painted, but should be thoroughly covered and protected with concrete when in place.

SIGNS, FENCES AND CROSSINGS

Specifications and plans for a standard highway-crossing sign and standard trespass signs are presented for adoption by the committee on signs, fences and crossings. For the former a wooden sign is recommended, for the latter, a cast-iron sign on a wrought-iron pipe set in concrete. The conclusions are based on an extensive investigation which included the legal requirements and trespass statutes in the various States.

The committee has met with little response in its efforts to arrive at ways and means for securing a proper quality of fence wire, and concludes, therefore, that consideration of the subject should be discontinued for the present. Arrangements have been made to test various kinds of concrete posts, and the committee hopes to present an interesting report on the subject next year.

SIGNALS AND INTERLOCKING

The committee on signals and interlocking reports progress in the study of economics of labor in signal maintenance, but has thus far considered only track forces. It suggests various lines along which the investigation should be followed, and recommends that the subject be continued. In the matter of requisites for switch indicators progress is reported and the hope is expressed that final report may be made next year. The third subject assigned to the committee was automatic train control. The committee thinks that inasmuch as the American Railway Association is considering the subject it would be inadvisable for the engineering association to proceed until the other committee has made its report.

Because of the growing importance of the track circuit as a controlling agency for all signal appliances the committee presents reports of various tests showing the conductivity of creosote and creosote-treated ties, and the effect of ballast and bonding conditions. The committee also offers twelve pages of symbols, which are those used by the Railway Signal Association, for substitution for the symbols at present in the "Manual."

RECORDS AND ACCOUNTS

Elimination of the foreman's diary (Form MW1101) is the chief of three "Manual" revisions recommended by the committee on records and accounts. The other amendments are of a minor nature. The committee has also carefully revised the conventional signs and symbols now in the "Manual," and offers the revision for approval. These are called for, as far as applicable, in the Interstate Commerce Commission's specifications for maps and profiles in connection with the Federal evaluation of common carriers. The committee gives these specifications, and also an abstract of the rules of the Railway Commission of Canada pertaining to maps and profiles.

No additional recommendations are made relative to the economical management of store supplies. After careful study of the report made last year, which was received as information, the conclusions therein are resubmitted for adoption.

The committee has continued its study of the subdivision of Interstate Commerce Commission classification account No. 6—roadway and track—and has enlarged upon the report submitted last year. The committee now proposes ten sub-accounts instead of nine, adding work-train service as a separate account. It also shows how to adapt the thirteen divisions of the Interstate Commerce Commission to the ten now proposed.

Progress is recorded in the investigation of reports required by Federal and State railway commissions.

RULES AND ORGANIZATION

The committee on rules and organization offers several revisions and additions to existing rules and proposes eleven general rules for the government of employees in the construction department, two rules pertaining to the organization of the department and twelve rules governing chiefs of survey parties and resident engineers.

WATER SERVICE

The committee on water service submits as information only a nine-page report intended to give the association a brief outline of the developments of water-softening on railways since the subject was studied by the committee in previous years. Particular reference is given to the relation of the problem of water-softening to railway operation.

Progress only is reported in the study of the design and relative economy of track pans from an operating standpoint, and of recent developments in pumping machinery. In an appendix is a report by J. L. Campbell, vice-chairman of the committee, on a series of tests of various metals for water-tanks, outlining their relative resistance to corrosive influences.

YARDS AND TERMINALS

Extensive reports on two of the four subjects assigned are presented by the committee on yards and terminals. On the subject of track scales the committee asks an extension of time to consider the amended specifications of the American Railway Association. As to typical situation plans for passenger stations arrangements are being completed for putting into use at some of the large terminals the diagrams submitted last year.

Twenty-six pages are given to the discussion of freight handling by mechanical means. While no formal recommendations are made, the committee expresses certain views. It thinks that while it is a simple matter to provide conveying devices between two fixed points, the problem has not yet been solved of a suitable system for handling packages of all sizes and weights between numerous points. The nearest approach is thought to be the substitution of small motor trucks for hand trucks.

On the subject of hump yards the committee describes the large yard recently completed by the Canadian Pacific Railway at Winnipeg, Man., and gives a list of hump yards in service and under construction in the United States and Canada so far as information could be obtained. The list contains ninety-five yards, representing thirty-one railroads. A summary is also given of answers from fifteen leading railroads to thirteen questions bearing upon capacities of hump yards, unit costs of operation as compared with flat yards, profiles at humps and other details of hump-yard design and operation.

Iron and Steel Structures

Nine subjects were assigned to the committee on iron and steel structures. On several of these the committee has nothing to report. Progress reports are submitted on methods of protecting iron and steel structures against corrosion, on secondary stresses and on the bridge clearance diagram, with the recommendation that they be accepted as information. A final report is offered for adoption in the matter of requirements for the protection of traffic at movable bridges. A revision of one of the "Manual" rules and the addition of two for the inspection of the fabrication of steel bridges are recommended, but no report is made on "Specifications for the Elastic Limit."

In connection with the bridge clearance diagram the committee has made an exhaustive study. Seven questions addressed to officials have brought responses from sixty-seven railroads. The committee believes, however, that any changes in the present diagram would have such far-reaching importance that nothing should be done hastily, and recommends that the subject be continued.

Economics of Railway Location

The committee on economics of railway location has not met during the year and has no progress to report. Effort was made by correspondence to establish definitions of "ruling grade," "value of distance," "rise and fall" and "curvature—compensated and uncompensated," but no conclusions were reached. The committee feels that future work along the line of economics of railway location must necessarily involve the analysis of a great many figures, the detailed working out of examples and the construction of many drawings and profiles, and that it should be done by men paid to devote their entire time to it. The committee believes that results of value to the railroad profession at large could be accomplished in this way. It therefore recommends the appropriation of $400 per month for six months and the employment of three men for that period at respective salaries of $200, $125 and $75 per month to report direct to the chairman of the committee.

C. P. Howard and E. C. Schmidt in a minority report state that they do not think this a good time to ask for an appropriation, and that in any event no one should be employed until sufficient data are on hand ready for analysis. They believe that the committee should continue the analysis of maintenance expenses to determine the proportionate costs of passenger and freight tonnage, and the relative damage to track per ton of engine and cars.

Wood Preservation

Investigation was continued by the committee on wood preservation of the merits as a preservative of oil from water-gas and the use of refined coal tar in creosote oil. The committee thinks that lack of data as to oil from water-gas makes it inadvisable at this time to recommend its use. As to mixing coal tar with creosote, the committee recommends that wherever possible only grade 1 coal-tar creosote should be used, and that under no circumstances should coal tar be added to creosote of this grade. The committee recognizes, however, that the inadequate supply of grade 1 creosote may impel roads to add coal tar to the creosote used. Six conclusions are added, therefore, stipulating various restrictions that should be imposed on such practice. An extensive paper on the subject by Hermann von Schrenk and Alfred L. Kammerer is appended to the report.

Relative to methods of determining accurately the absorption of creosote oil, the committee has investigated three systems in general use—by gage readings of tanks, with temperature corrections; by weighing the oil in the working tanks before and after treatment of charges in cylinder, and by weighing the cylinder charges before and after treatment. These two conclusions are reached: (1) At railroad plants the absorption should be based on the treatment which will give the most complete penetration for each class or kind of timber, specifying complete penetration of the sapwood and as much of the heart as possible for the particular species or charge—payment to be based on the amount of oil used, plus operating and other charges. (2) Where railroads have their work done by contract gallons should be specified for ties, posts, crossarms, and other material of uniform size, and pounds per cubic foot for other material —the same requirements as to sap and heart penetration to be applied as in case 1.

The committee also presents a record of 268 tie service tests and reports progress in the grouping of timbers for antiseptic treatment.

Electricity

The committee on electricity has continued its study of clearances, collecting and tabulating data from electrified railroads and co-operating with the American Railway Association and the American Electric Railway Association. No final conclusions have been reached as to third-rail clearances, the joint committee agreeing that further study should be given the equipment clearance line adopted in March, 1912, by the American Railway Engineering Association, and that inasmuch as the development of automatic train stops or speed-regulation devices is in an experimental stage no further consideration should be given at this time to their location on the track structure. A table corrected to date regarding third-rail clearances is given.

Five diagrams are presented for adoption covering overhead clearances under various conditions. Four of these, applicable to pantograph trolleys where trainmen are allowed on top of cars with or without lanterns and for normal and minimum conditions where men are not allowed on cars, are taken from a committee report of the American Railway Association. The fifth indicates a minimum underclearance applicable to the overhead direct-current rail, based upon the minimum permitted by the New York Public Service Commission. A table of overhead clearances in use is also submitted.

Conservation of Natural Resources

The committee on conservation of natural resources, formed to keep in touch with the general work of Federal, State and Provincial conservation organizations, with particular attention to matters of interest to railways, presents a review of conservation work of the year. Its only recommendation is one urging the study and practice of timber preservation, both as an economic proposition and as a check on the rapid depletion of forests.

Uniform General Contract Forms

The special committee on uniform general contract forms has continued its study of the contract form and has reached conclusions as to proposal blanks. A form of proposal is offered for adoption. The committee has been unable to complete the form for "Construction Bond." It therefore recommends that when the form is completed the secretary of the association send it out to the railroads for criticism by their legal departments.

Grading of Lumber

The special committee on rules for the grading of lumber reports that it has endeavored to formulate additional grading rules for such classes of lumber as have not yet been standardized, but has been hampered by the fact that many of the rules for such timbers are still in a state of development. The committee has deemed it advisable to await the definite adoption of such rules by the associations manufacturing these classes of lumber.

Drainage Project for Lower Egypt

LORD KITCHENER, the British consul-general for Egypt, proposes to construct a comprehensive scheme of drainage in the Delta of the Nile. Eventually about 400,000 acres will be reclaimed. The machinery will be installed in the large pumping station being erected at Khasa, in the vicinity of the sea coast midway between the Damietta and Rosetta mouths of the river. The station is to be capable of lifting in twenty-four hours 146,340,000 cu. ft. of water against a head varying from 6 ft. 10 in. to 9 ft. 6 in. The pumps may either be turbine or centrifugal, and the main engines are to be of the Diesel type.

The pumping plant will consist of fifteen units, each having an engine directly coupled to a pump capable of discharging 395 cu. ft. per second against a head of 8 ft. 3 in.

St. Louis Builds World's Largest Mechanical Filter Plant

Abstract of Paper by Commissioner Edward E. Wall
Presented to Illinois Water Supply Association March 9

ABOUT two years ago it became evident that the capacity of the St. Louis water-purification plant in use was too small for the treatment of the quantity of water consumed by the city. The eight years of operation of the purification process had also forced all of those who had been connected with the installation and development of the process reluctantly to admit that it was not as efficient as filtration; that there were difficulties of operation that had not been satisfactorily overcome; that there were objections that could not be altogether removed. Whether to increase the capacity of the system by perpetuating the method in use, or by utilizing the machinery and basins for the preliminary treatment of the water and then passing it through rapid sand filters, became principally a question of economy in first cost and operation. Careful estimates on the cost of increasing the capacity to 150,000,000 gals. per day showed that to build additional basins, conduits, etc., to enlarge the present system would cost at least $250,000 more than to build a rapid sand filter plant to supplement the treatment in existing basins. It was also estimated that the cost of treatment and operation would be less with the filters. Considering also the unquestioned fact that the general quality of the water would be improved, and that a uniform clarity of water would be insured by filtration, there could be no hesitation in making a decision in favor of the construction of the rapid sand filters.

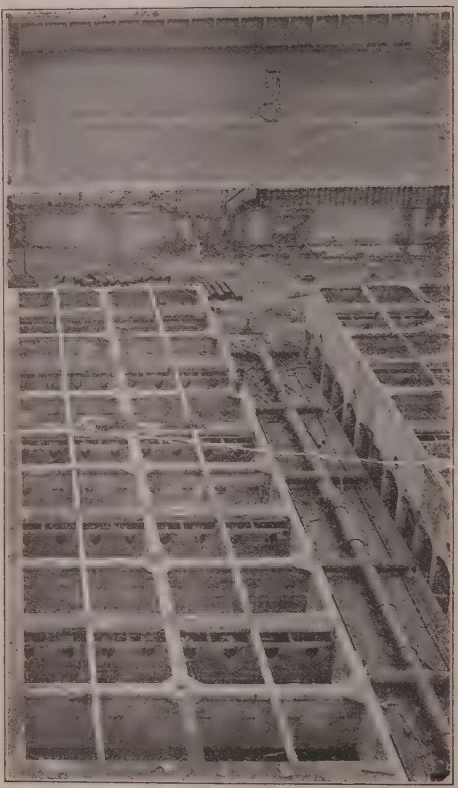
ARRANGEMENT OF FILTERS

The Chain of Rocks works included a coagulant house and nine settling basins. The filters are in the western portion of basin 7, occupying a space approximately 700 x 140 ft. The filters were located in the basins, rather than on ground outside, for several reasons: The space taken from the basin could be readily spared, since ample basin capacity for coagulation and clarification would remain, construction could proceed more rapidly, since no excavation was necessary, better and more convenient arrangements for utilizing existing conduits and making new basin connections could be had, and, on the whole, the cost would be decreased by such a location.

The design provides for forty 4,000,000-gal. daily filter units, each 50 x 28 ft. in plan, supported on concrete columns 20 in. square, spaced 11 ft. on centers north and south and 10 ft. 3 ins. on centers east and west.

On the original basin floor inverted concrete arches were laid to distribute the foundation loads of the columns. The filter boxes rest on the reinforced concrete floor formed by leveling up the groined arches joining the tops of the columns. Each filter box is poured as a monolith, the concrete mixture being 1:2:4, with 25 lb. of hydrated lime added for each barrel of cement, for the purpose of making the boxes watertight. The concrete in the columns and arches is composed of a mixture of 1:2½:5. Screened and washed gravel has been used throughout for the coarse aggregate.

The strainer system consists of the channel type, in which the drains are formed by and between concrete ridges and covered by perforated strainer plates anchored to the concrete by bronze bolts and bars. Along the center of each half of each filter unit is formed a collecting channel, 28 ins. wide by 5 ins. deep, into which all the small lateral drains 3 ins. wide by 5 ins. deep empty. Four 10-in. openings in the bottom of each collecting channel are connected by cast-iron pipe to the effluent conduit. The water will be filtered through 30 ins. of sand with an effective size of from 0.5 to 0.6-min., and 12 in. of gravel.



Concrete Filter Boxes and Gallery

The sand will have a uniformity coefficient not greater than 1.65. The gallery between the filters contains the effluent conduit, 15 ft. wide and 4½ ft. high, over which lies the 36-in. cast-iron wash-water pipe, and above that is the influent flume, 15 ft. wide and 10 ft. deep, into which the water is drawn at each end of the filter house from basins 7 and 8. Both the influent and effluent flumes are built of reinforced concrete. The cover of the influent flume will be the operating floor of the filter house.

RATE OF FLOW

The rate of flow through each filter will be maintained by a rate controller placed on the 24-in. effluent pipe. Each controller can be set to maintain any desired rate of flow between 1,500,000 and 5,000,000 gals. per twenty-four hours, regardless of the difference in head on the two sides of the controller; this difference may amount to as much as 14 ft.

The registered flow shall not vary more than 3 per cent. from the actual flow below the 2,500,000 gals. daily rate, nor more than 1½ per cent. when the rate is above that amount. These forty individual controllers will be connected to a master controller, which when set at any desired rate of flow will automatically set the individual controllers on each filter at the same rate.

The operation of each filter will be handled from an operating table on the central gallery floor. The twenty-four-hour records of the height of water on the filter, the loss of head through the filter and the actual quantity of water passing through the controller will all be kept on one sheet. A recording gage will also show the elevation of water in the effluent conduit at the center of the filter house.

Venturi meters with recording attachments will be placed on the 36-in. wash-water pipe and on the outlets of the collecting conduit. These meter records, together with the individual records of each filter, will afford independent measurements of the quantity of water passing through the plant, and which again may be checked against the pumping records, which are also made by Venturi meters.

The filter house, which will entirely cover the filters, will be built of concrete with metal window sash and frames. The current for lighting the filter and head houses and for operating motors will be furnished from a brick 58 x 66 ft. generator house, located at the south end of the pumping engine house. The machinery will consist principally of two 250-kw. steam-driven units.

HEAD HOUSE

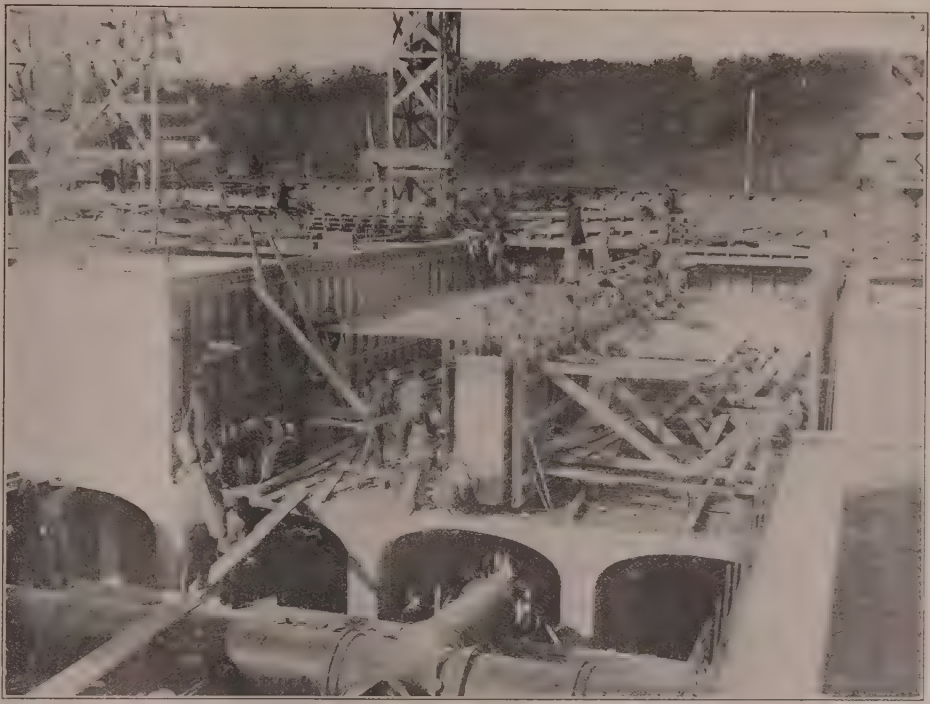
The head house is to be a four-story concrete building, on the first floor of which will be three 150-hp tubular boilers, four alum solution tanks, two alum solution pumps, three 12-in. centrifugal pumps for filling the wash-water tanks, two 6-in. pressure pumps for operating hydraulic valves, a 4-ton refrigerating plant for manufacturing ice for the department, a storeroom for hypochlorite of lime and liquid chlorine, and a small machine shop. On the second floor will be located an office, a small laboratory, six alum mixing tanks, washrooms, lockers and storeroom. Two wash-water tanks, each 50 ft. in diameter and containing 175,000 gals. of water, will occupy the greater part of the third and fourth floors. The dome-shaped covers of these tanks will form a portion of the roof of the building. There will be space on the third floor for the solution tanks for hypochlorite of lime and for the liquid chlorine apparatus, and on the fourth floor the space will be utilized for hypochlorite mixing boxes and storage for alum.

Alum will be unloaded from the railroad cars into an elevator chute, from which it will be elevated and conveyed to the storage bins on the fourth floor.

The settling basins, except No. 7 and No. 8, will be used as primary coagulating basins, and will be operated in parallel, the present system of operating in series being abandoned. Before the water reaches these basins and before any chemicals are used it will pass through a grit chamber, 70 x 100 ft., where the heaviest of the matter in suspension will be precipitated. As the water leaves the grit chamber it enters the first channel of the mixing chamber, where it will receive the charge of lime. The mixing chamber consists of four parallel channels, each 7 ft. wide by 11 ft. deep, through which the water may be directed in series or in parallel. Used in series the water will be made to travel about 10,000 ft. between the grit chamber and the filling conduit, while by using the channels in pairs only half that distance will be traversed. The object in varying the distance through the mixing chamber is to be able to approximately regulate the carrying capacity of the chamber to the variable quantity of water being pumped, so as to maintain the velocity sufficiently high to prevent settlement in the channels.

CHEMICAL TREATMENT

The effect of the passage of the water through the mixing chamber is to insure the thorough mixing of the milk of lime with the water, and also to allow a longer time for the softening action of the lime before the sulphate of iron is added. This will result in an estimated saving of probably 30 per cent. in chemicals, because of the elimination of loss due to incomplete chemical reactions. The water, on leaving the mixing chamber and entering the filling conduit, will receive the charge of sulphate of iron. The inlets from the filling conduit to each basin will be baffled to prevent direct flow across the basins. The water will be drawn from the primary basins into a concrete collecting conduit, located between the two sets of basins. From this conduit it will be delivered and measured through two Venturi meters, with 56-in. throats, into a chamber 75 ft. wide, extending the full distance across the north end of basin 7. As the water enters this chamber it will receive any secondary treatment that may be necessary before it is drawn into basins 7 and 8. The addition of hypochlorite of lime or liquid chlorine when necessary may be made just before the water goes to the filters, or these chemicals may be applied to the filtered water as it leaves the filter house.



Forms in Place for Filters over Groined Arch Reservoir Roof

CONSTRUCTION PROGRESS

The contract for the concrete substructure, filter boxes, conduits and connections was awarded to the McCormack-Coombs Construction Company of St. Louis on April 18, 1913, for the sum of $225,023.10. Because of the location of the filters in basin 7 it was possible for the contractor to design a comparatively simple plant for mixing and placing concrete. A switch-track was laid along the basin wall, so that material could be dumped from cars into bins above the mixer, which was placed in a pit 22 ft. below the surface of the ground. One of the bins holds about fourteen cars of gravel, the other about ten cars of sand, while the adjacent cement shed will contain 1500 bbls. of cement.

The 22-cu. ft. Lakewood mixer discharges into a skip operated in a tower 119 ft. high. From this main tower chutes run for the entire length of the filters, a total of about 700 ft. Concrete can be taken from the main chutes at any one of the twelve towers and carried to any part of the work. The grade of the main chutes is 20 per cent. They are made of wood, lined with sheet iron, are 12 ins. in width and depth and span 45 ft. between towers. The movable chutes are made of steel in one piece and are 12 ins. wide by 10 ins. deep. The velocity with which the concrete flows from the main tower to its destination is about 480 ft. per minute.

The mixing and placing of concrete was begun July 17, 1913, and up to Feb. 1, 1914, a total of 165 working days, 14,428 cu. yds. of concrete have been poured. This includes the entire substructure, thirty-eight filter boxes, the effluent conduit and the greater portion of the influent conduit. Twenty-four filter boxes were poured during 27 consecutive days in December and January, each box containing 107 cu. yds.

COST

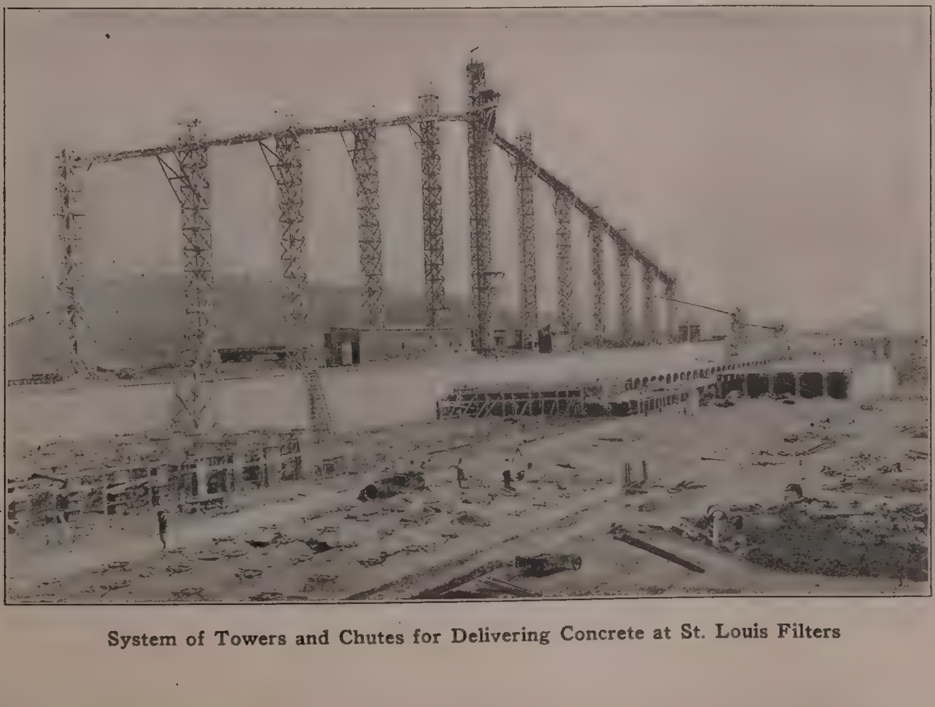
The cost of erecting form work for the walls, columns, and arches was $1.65 per cubic yard of concrete, and for the effluent conduit $1.55 per cubic yard.

There follows the list of contracts let and the estimated costs of the work necessary to complete the plant:

Filters—McCormack-Coombs Construction Co.	$225,023.10
Filter equipment—Pittsburgh Filter Manufacturing Co.	398,200.00
Filter house—McCormack-Coombs Construction Co.	89,730.00
Head house—Estimated cost	185,000.00
Waterproofing basins 7 and 8—Estimated cost	50,000.00
Raising division walls—Estimated cost	85,000.00
Generator house—Estimated cost	50,000.00
Mixing chamber—Estimated cost	160,000.00
Total	$1,243,953.10

Contracts for the last five items will be let within sixty days, and it is intended to have the plant ready for operation by Nov. 1. All contracts will require completion before that date under heavy penalties for overtime. This plant, when completed, will be the largest mechanical filter plant in the world.

A SHIP canal to Budapest from the Adriatic Sea is said to be under consideration by the Hungarian Government. The canal will run from the Danube to Platten Sea and through this lake to the rivers Drave and Save. It will have locks and its construction will take from six to eight years.



System of Towers and Chutes for Delivering Concrete at St. Louis Filters

Board Reports on Electrolysis Conditions in Springfield, Ohio

Insulated Return System of Feeders for Street Railways Supplemented by Track Bonding Found to Be Best Remedy

ELECTROLYTIC damage to underground structures in Springfield, Ohio, has been prevented by the installation of insulated return feeders, supplemented by track bonding, on the lines of the Springfield Railway Company and the Ohio Electric Railway Company. That this is the best method of protecting underground structures from stray currents is the conclusion reached by an investigating board of thirteen engineers representing the U. S. Bureau of Standards, the city of Springfield, and all of the public utilities concerned in the local electrolysis situation. The board's report, abstracted below, was submitted to City Manager Charles E. Ashburner on Feb. 11. It states that the present voltage conditions in the tracks in Springfield, as shown by the electrical survey just completed, are almost as good as the corresponding conditions in Great Britain and other European countries, where experience has shown that there is substantial freedom from injury by electrolysis of underground structures.

In constructing this insulated return feeder system the Ohio Electric Railway Company installed 20,100 lb. of return feeder copper and the Springfield Railway Company 63,400 lb.

RECOMMENDATIONS

The board has submitted the following unanimous recommendations:

1. The insulated return feeders now installed should be made permanent.
2. No insulated negative feeders are necessary on the interurban lines at present, provided adequate track bonds and cross bonds are installed and maintained on the tracks of these lines, although such feeders may become necessary in the future.
3. All electric railway tracks within the city limits should be so constructed and maintained that every joint in each rail has a resistance which does not exceed the resistance of 8 ft. of rail.
4. Arrangements should be made whereby all electric railway tracks within the city limits shall be inspected at least once each year and a report of such inspection filed with the city manager.
5. No metallic connections between the water or gas pipes and the railway return circuit should be permitted.

INSULATED FEEDERS

The system actually installed included insulated return feeders for the Ohio Electric Railway as well as for the Springfield Railway Company, the former company now having installed negative copper amounting to 33 per cent of its positive copper, and the latter company 35 per cent. The conditions were very favorable to a system of insulated negative feeders owing to the fact that the substations of the two companies were at opposite sides of the city, so that by interconnecting the tracks it has been possible to interchange current on the negative sides to a very considerable degree, thus aiding in securing low potential differences.

The negative feeders were designed to reduce the potential gradient in all parts of the track system to a mean value not exceeding 0.5 volt per 1000 ft. under net average schedule traffic. This corresponds to approximately 0.8 volt per 1000 ft. averaged during the hour of peak load. The test data show that this condition has been substantially realized.

The report states that the present conditions existing in Springfield correspond to those prevailing in cities in Great Britain and Germany where experience has shown that there is substantial freedom from injury by electrolysis. The regulations in effect in Great Britain as stated by the report limit the maximum over-all voltage drop in any city to 7 volts, the maximum being defined as a mean value between the highest momentary peak and the average for the hour of maximum load. In Springfield the tests showed that the highest value obtained exceeded the British limit by only 2 volts, and in the majority of cases the over-all voltage readings were considerably lower. The limiting value prescribed in Germany prevents the over-all voltage within city limits from exceeding 2.5 volts during average schedule traffic. In Springfield only 19 per cent of the readings were above this.

GRADIENT MEASUREMENTS

With regard to potential gradient measurements the largest average value in Springfield for any one hour was 0.98 volt per 1000 ft. This, however, was due to defects of track which could be repaired. The average of all the values obtained throughout the city was 0.23 volt per 1000 ft. The German regulations prescribe for suburban lines a gradient limit of 0.3 volt per 1000 ft. of track during average scheduled traffic. In Springfield the average of all peak load gradients is found to be 0.35 volt for the hour and 0.64 volt for the highest ten-minute period.

The over-all voltage prescribed by law in Lorain, Findlay, Galion, Fremont and Canton, Ohio, is limited to 7 volts between any two points on the non-insulated portion of the track return during the ten minutes showing the highest value, and the potential gradient for the corresponding period is limited to 1 volt per 1000 ft. The values of over-all voltages and potential gradients existing in Springfield are considerably below these limits, except in isolated cases where there is bad rail bonding.

From the results obtained the authors of the report state that they are convinced that the insulated return-feeder system combined with proper maintenance of track bonding is the best means of dealing with the electrolysis problem in all cases where it is not practicable to insulate the tracks from the ground.

The report makes strenuous objection to the use of pipe drainage under any circumstances for the city of Springfield, but instead recommends that the insulated return-feeder system should be supplemented by a certain proportion of insulating joints in the water pipes and gas pipes. With regard to lead cable sheaths of the telephone and telegraph companies, however, it says that it would not be commercially practicable to extend the insulated return feeder system so that they could be safeguarded against electrolytic action. It is therefore cheaper to apply a limited amount of drainage protection to the cables, which, being continuous conductors, can be protected in this way. The problem of draining cables differs in many respects from that of draining pipes, particularly in that cables are continuous conductors and the difficulties arising from high resistance joints are not encountered. Great care, however, should be exercised not to overdrain the cables, as such overdrainage may involve danger of electrolytic action in nearby structures.

Consulting Engineers Oppose Charges for Contract Plans

American Institute of Consulting Engineers' Committee Report by W. J. Wilgus and F. A. Molitor

THE custom of making charges or demanding deposit for blueprints and specifications issued to the contractor has been investigated by a committee of the American Institute of Consulting Engineers, and the following report, signed by William J. Wilgus and F. A. Molitor, has been adopted:

"In respect to charging a fee for the use of plans, it is our opinion that, when contractors are invited to bid upon any work, the necessary plans should be furnished to them by the engineer without charge. If, however, the work is to be publicly let, there should be some limitations made with regard to the number of plans to be furnished free by the engineer. We believe that in such case the public or advertised invitation for bids should provide that the plans be on view at one or more places where all bidders can conveniently call and examine them. If prospective bidders ask for the use of plans under this last condition, we believe that the engineer should require a deposit for them, which deposit may be in an amount sufficient to insure the return of the plans, and that when such plans are returned to the engineer, after the award is made, the engineer should return the amount of the deposit.

"We are of the opinion that a sufficient number of plans for the execution of a contract should be furnished the contractor without charge. As to the number of sets of such plans, we are unable to make any definite recommendation other than that we believe the engineer should furnish sufficient for all reasonable construction purposes, and for any number in excess thereof he should charge the cost of reproduction.

"We believe that the engineer employed by a private client should lend his influence against the requirement of a deposit of a certified check by a contractor bidding upon his work.

"We are of the further opinion that it would be advisable in the interest of all concerned that the subject matter of the General Contractors' resolution be discussed by a joint committee composed of equal representation from the American Institute of Consulting Engineers, Inc., the American Institute of Architects, and the General Contractors' Association.

"We therefore recommend that the secretary of the American Institute of Consulting Engineers, Inc., be directed to invite the other two associations in interest to join them in the appointment of a committee which may take up this subject to the mutual benefit and interest of all."

This report has been approved by Lincoln Bush, J. E. Greiner, William Barclay Parsons, C. C. Schneider, L. B. Stillwell and John F. Wallace.

CHARCOAL is made from waste wood from sawmills at an electric-process plant using cheap power near Vancouver. The plant has been in operation for six years.

Cutting Up Wreck of Steel Ship with Oxyacetylene Torch

The "Alum Chine," Destroyed by Dynamite Explosion in Baltimore Harbor, Was Raised and Cut into Steel Furnace Scrap

THE tangled wreckage of the 1800-ton steel freight steamer "Alum Chine," which was destroyed March 7, 1913, by an explosion of 300 tons of dynamite in the hold of the vessel while she lay in the lower harbor of Baltimore, has recently been reduced to steel-mill scrap with the aid of an oxyacetylene cutting torch. The violence of the explosion was so great that the entire forward part of the ship was blown away, the deck and upper works being reduced to bits and scattered over the harbor and adjacent shores for a radius of several miles, while the major part of the hull was thrown to the bottom in 33 ft. of water. Pieces of steel 3 to 5 ft. long were found from 2 to 3 miles from the wreck.

A survey of the site showed that the after part of the hulk, containing several hundred tons of steel, lay just outside the channel, covered by about 13 ft. clear depth of water. The entire upper works, boilers and engines were gone, and the steel beams and plates were badly bent and twisted. It was necessary to remove the wreck in order to protect navigation and a contract for this work was let during the past summer to the Merritt & Chapman Derrick & Wrecking Company, of New York.

Lifting Heavy Stern Section of Wrecked Ship from Scow

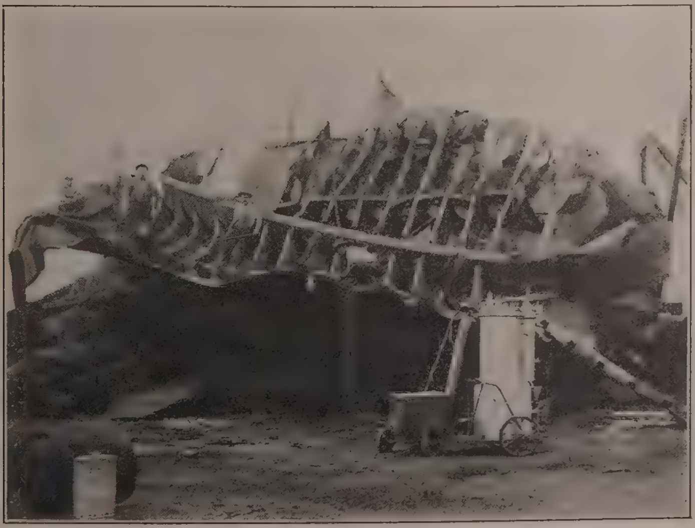
DYNAMITING UNDER WATER

An 80-ton steel floating derrick was detailed to the work. Divers were sent down to lay strings of dynamite, which were exploded under water so as to cut the hulk into pieces of a size that could be handled by the derrick. The sections were then lifted onto a scow and towed to the dock and yard of the Southern Iron & Metal Company, of Baltimore, which purchased the steel from the wrecking contractors for disposal as steel furnace scrap. At the dock the floating derrick laid down the 25 to 40-ton pieces of the hull in a huge pile.

Each large piece was a shapeless mass, with the plates, beams and members bent and crumpled. Rivets could not be removed to good advantage, since in many cases the flanges of angles or pieces of plate were bent over flat against them, preventing access to their heads. Most of the skin plate of the ship was $\frac{5}{8}$-in. steel, running to greater thicknesses in some portions along the bottom. The ribs and longitudinal frames were deep, built-up sections of plate and angles. The condition of the steel was such that the expense of ordinary hand cutting would have been prohibitive and the wreckage would have been a total loss had the oxyacetylene process not been available.

An oxyacetylene plant mounted on a truck for portability was supplied by the Alexander Milburn Company, of Baltimore. One torch operator was employed, long lines of gas hose being provided to allow him sufficient freedom of movement about the wreckage to attack it from points of greatest convenience. As fast as the pieces of steel of suitable size for handling were cut out by the torch they were loaded on wagons and then placed on freight cars for transportation to the mills.

On account of the condition of the steelwork and because of inaccessibility it was impossible to establish a definite routine of dismantling the wreckage. The work was simply started from the top or one side of the pile and carried as far as convenient from that point, then resumed from some other point.



Torch Operator Starting to Make Cut in Bottom Plates

Oxyacetylene Outfit at Work on Twisted Plates

Replenishing Underground Water

REPLENISHMENT of underground water supplies by artificial means was suggested in a recent memoir of the Geological Survey of England, dealing with the wells in the London district. It was proposed that the water falling upon the impervious stratum surrounding London should be drained into wells, carried down to the level of the Thanet sands so that it could find its way to the water bearing stratum, which is chalk. An enormous quantity of water which now runs to waste would thus be collected. This would be stored in the fissures of the chalk and would raise the level of the water through the London district, which level has fallen 100 ft. or more within recent times owing to the enormous amount of water which is pumped therefrom. The suggestion, so it was stated by H. C. H. Shenton in his presidential address before the Society of Engineers, England, is based on experiments at Lea Bridge, where a large quantity of filtered Lea water was run into the wells, with the result that the well supply was materially improved during the drier periods of the year.

Action of Sea Water on Concrete

Results of Six-Year Test of Twenty-three Molded Piles of Various Mixtures Submerged in Boston Harbor and Withdrawn Periodically for Examination

Accompanied by folded insert with pictures showing present condition of concrete piles

TO secure authentic data on the disintegration of concrete between tide levels, and particularly to determine whether chemical action or frost action is the more largely responsible for such surface spalling as takes place, arrangements were made in 1908 between the Aberthaw Construction Company of Boston and the United States Navy Department for a long-time test of twenty-four piers. The piers measured about 16 ft. in length and 16 ins. square, were constructed by the company in the Charlestown Navy Yard and hung under the cap of one of the piers in that yard, where they have been subjected to widely changing temperatures. Portions of them have been alternately immersed in the water and exposed to the air—with the ebb and flow of the tide.

The Government detailed an officer of the navy yard to record these tests, while Herbert L. Sherman, chemist, of Boston, made careful analyses and records of all the cement, aggregate, stone and sand entering into the work. The samples have been examined at considerable intervals, the last examination having taken place in December, 1913. The Aberthaw company has assembled the following data regarding the tests:

DIFFERENT CONCRETE MIXTURES

Under the specifications which were prepared for this work, in conjunction with the Navy Department, the first three specimens were made of 1 part cement, 1 part sand, and 2 parts stone, mixed dry, plastic and very wet, respectively. The next three were made of approximately 1 part cement, 2 parts sand, and 4 parts stone, but so proportioned after mechanical analysis of materials that the excess of cement over voids of sand should be 10 per cent., and the excess of mortar over voids of stone should be 10 per cent. These three were mixed dry, plastic and very wet, respectively. The next three were made of 1 part cement, 3 parts sand, 6 parts stone, and mixed dry, plastic and very wet, respectively.

Ten samples were made in pairs, one of each pair being mixed 1:1:2 and the other 1:3:6. All of these were mixed wet. Two were made from a Portland cement free from iron, two of commercial Portland cement high in alumina, two of a commercial Portland cement low in alumina, two of an iron ore cement practically free from alumina, and two of slag cement.

The other five samples consisted of 1 part cement, 3 parts sand, and 6 parts stone, and were mixed quite wet. No. 20 was most thoroughly mixed—much better than commercial mixing. No. 21 was mixed with sea water instead of fresh water. No. 22 had one-tenth part by weight of hydrated lime substituted for an equivalent amount of the cement, thus making the mixture really 0.1 hydrated lime and 0.9 standard Portland cement, 3 parts sand, and 6 parts stone. No. 23 contained Sylvester mortar and No. 24 contained finely pulverized clay to the amount of 5 per cent. of the weight of the cement.

The tops of the piers, as hung, are 18 ins. below mean high water. With the mean tide of 10 ft. this leaves 4½ ft. continually immersed below low water, except under unusual tide conditions. The maximum tide puts the water about a foot higher—within 6 ins. of the top of the piers.

CASTING PILES

The specimens were cast in a horizontal position in January, 1909, in one of the navy yard buildings, where the temperature was kept above freezing, but not very warm. To give them stiffness so that they could be handled without breaking, a ⅝-in. square twisted steel bar, bent into a loop, was embedded for the full length of the bars, the loop projecting from one end. In the upper end of each specimen a steel pipe, 2½ ins. in diameter, was embedded for a depth of 8 ft., thus coring a hole to measure water percolating into the specimen from the sea. After this pipe was removed a short 3-in. pipe, threaded and capped, was fitted at the top of each pier to keep out rain and splashings. To prepare for the removal of the 2½-in. pipe it was thoroughly coated with paraffin wax before being embedded in the cement. After the material had set live steam was turned into the pipe, thus melting the wax and making the withdrawal of the pipe easy.

When the Government rebuilt the wharf under which these specimens were first hung it was necessary to move them (in November, 1912) to another wharf. At this time the ⅝-in. reinforcing bars, the loops of which had been used to handle the specimens, were found to be weak. Hooks were therefore grouted into the holes in the piers, which were thus solidly filled up. These hooks will be seen in the illustrations.

The stone used was broken trap rock from quarries at Malden, Mass., weighing 90.24 lb. per cubic foot, the voids being found to be 50 per cent. This stone passed a 1¼-in. ring. The sand, which was obtained from banks at South Acton, Mass., was clean and sharp, and a trifle finer than usual. Dry, it averaged 97.18 lb. per cubic foot, while the voids were found to be 34.2 per cent. As used, this sand contained 4.6 per cent. of moisture.

The specimens remained in the building about five weeks before being hung from the cap log. They have been examined a number of times, being handled by a floating crane belonging to the Navy Department. On Dec. 22, 1909, the holes in the piers were sounded for water. Sixteen of them were dry. The others contain from 1 in. to 65 ins., as follows:

No.	Inches	No.	Inches
1	38	7	19
2	65	8	22
4	60	15	27
5	52	21	1

The specimens were examined March 3, 1910, most of them being apparently in as good condition as when placed. Some of them showed slight surface erosion, extreme at about half tide, the aggregate being exposed, but still firmly embedded. The extreme erosion in one case was about 1 in. Some of the samples appeared to be soft on the surface, indicating chemical action. Two of them which were cracked in first placing had become worse during the interval.

The specimens were photographed Dec. 21, 1909, July 22, 1911, and Dec. 17, 1913. The latter are the views given in the folded insert which accompanies this article.

AGGREGATES

Nothing out of the ordinary was noticed in the tests of the cement used for the piers except for the very long time taken by the iron ore cement in getting a hard set. This is interesting as showing the effect of the set of the almost total absence of alumina. The use of hydrated lime was shown to give a very quick set—although the initial set was very rapid, the paste is easily worked to a soft mix for several hours after getting its initial set. The log of tests of the various cements used is shown in the accompanying table.

The sand was very fine, clean and of good quality. As used, it contained 4.6 per cent. moisture. The voids measured 34.2 per cent. By weights the sand passed different meshes shown in one of the tables.

TESTS OF SAND

Sieve Number	Per cent	Sieve Number	Per cent
100	4.8	10	91.0
50	24.0	8	93.4
30	52.0	6	96.1
20	73.4	¼ in.	100.0
16	86.4		

The stone was a broken trap, of very good quality, containing 50 per cent. of voids by volume. The fineness in passing sieves is represented by weights, shown in one of the tables.

TESTS OF STONE

Inches	Per cent	Inches	Per cent
⅛	0.25	½	25.25
3/16	0.50	¾	53.0
¼	1.75	1	80.75
⅜	9.75	1½	100.0

The specimens were all cast during the period from Jan. 8 to 16, 1909. The forms were removed two or three days later, and the test pieces were all immersed between Feb. 23 and March 1, 1909, and left in the water. The condition when cast and when examined in March, 1910, and December, 1913, is as follows:

CONDITION BEFORE AND AFTER SUBMERGENCE

SAMPLE 1.—When cast, water glistened but did not spatter; concrete did not quake.

March 3, 1910.—Front face showed some slight surface erosion, extreme at about half tide.

Dec. 17, 1913.—Face eroded badly for full length. Sides and back probably as good as when poured.

SAMPLE 2.—When cast no water spattered from surface by tamping, but a little movement could be seen as far as 12 ins. away.

March 3, 1910.—Apparently in as good condition as when placed.

Dec. 17, 1913.—Face, sides, and back sligthly pitted below midwater. Specimen seems in good condition.

SAMPLE 3.—When cast the concrete was soft enough to run out of an overturned barrow, but it would not flow like syrup.

March 3, 1910.—Apparently in as good condition as when placed.

Dec. 17, 1913.—Face somewhat pitted.

Edges good, sides good, back good, slightly pitted.

Sample 4.—When cast there was no free water, but the surface was moist.

March 3, 1910.—Slightly pitted on the sides, more so on front face, where the fine material had apparently been eroded, exposing the stones but leaving them firmly embedded. The extreme erosion was about 1 inch.

Dec. 17, 1913.—Face badly eaten from high water to bottom; a little worse between high and low water. Aggregate exposed on entire face; back good, slightly flaked at mid-water. Sides look as though specimen had been poorly spaded; aggregates exposed in streaks.

Sample 5.—When cast the top surface was quite wet, just barely spattered and quaked a very little at a few inches from tamp.

March 3, 1910.—Apparently in as good condition as when placed.

Dec. 17, 1913.—Specimen slightly pitted on all sides from high water to bottom.

Mixture and Weight of Concrete

Sample Number	Cement	Sand	Stone	Pounds of water	Net wt. conc. cu. ft., lb.
1	1	1	2	248	152.10
2	1	1	2	295	151.06
3	1	1	2	425	145.04
4	1	2½	4½	165	145.82
5	1	2½	4½	195	150.30
6	1	2½	4½	345	152.20
7	1	3	6	182	142.50
8	1	3	6	240	146.58
9	1	3	6	343	145.40
10	1 (a)	1	2	305	142.10
11	1 (a)	3	6	353	146.20
12	1 (b)	1	2	325	145.90
13	1 (b)	3	6	345	142.80
14	1 (c)	1	2	330	144.20
15	1 (c)	3	6	335	142.70
16	1 (d)	1	2	315	142.70
17	1 (d)	3	6	293	145.90
18	1 (e)	1	1	330	145.60
19	1 (e)	3	6	370	143.30
20	1	3	6	275	145.50
21	—	—	—	—	—
22	1 (f)	3	6	325	146.70
23	1 (g)	3	6	298	137.90
24	1 (h)	3	6	275	151.60

a, Blanc; b, Atlas; c, Helderberg and Lehigh mixed; d, iron ore cement; e, Universal; f, 0.9 cement and 0.1 hydrated lime; g, with Sylvester solution, soap and alum; h, 5 per cent pulverized clay.

Sample 6.—Cast very wet.

March 3, 1910.—The surface appeared to be somewhat soft.

Dec. 17, 1913.—All sides in good condition for full length. Face a little pitted; corners eaten a trifle around low tide.

Sample 7.—When cast did not quake.

March 3, 1910.—Slightly pitted on the sides; more so on front face, where the fine material had apparently been eroded, exposing the stones but leaving them firmly embedded.

Dec. 17, 1913.—Specimen entirely eaten through at 3½ ft. above low water; about a foot in length all gone; bars holding together; back side eaten on a slant for ten feet; only slightly eaten below low-water line; material dead at eaten section.

Sample 8.—When cast moderate tamping showed quaking; spots of water on surface.

March 3, 1910.—Apparently as good condition as when placed.

Dec. 17, 1913.—Front and sides somewhat pitted. Back face eaten badly from low tide to mid-tide for about 2 ft.—eaten to a depth of 5 ins. Streak eaten down center of back side from high tide to bad spot.

Sample 9.—When cast concrete spattered and quaked; water ran off.

March 3, 1910.—Apparently in as good condition as when placed.

Dec. 17, 1913.—General condition good; face a little pitted; edges all eaten a little.

Sample 10.—When cast concrete quaked when tamped lightly; cement acted quickly.

March 3, 1910.—Apparently in as good condition as when placed.

Dec. 17, 1913.—Condition good; bottom and sides hardly touched; front slightly pitted; edges fairly sharp.

Sample 11.—When cast flowed off shovel easily and concrete when tamped flowed water off form.

March 3, 1910.—Apparently in as good condition as when placed.

Dec. 17, 1913.—Condition good; face pitted slightly from mid-water; back good; sides slightly pitted around low-tide mark; edges fairly good.

Sample 12.—When cast quaked with light tamping.

March 3, 1910.—A very slight action was noticeable on the front face.

Dec. 17, 1913.—Very good condition; edges all sharp at mid-water; a slight flaking in back; front slightly pitted from mid-water to bottom; a little more above low water.

Sample 13.—When cast flowed off shovel easily; slight tamping showed quaking; spattered when tamped hard; surface glazed.

March 3, 1910.—A very slight action was noticeable on the front face.

Dec. 17, 1913.—Condition fairly good from top to low-water line; one corner at low water eaten in about 1½ ins.; sides good; back good; bottom good; face eaten, a little rough all way down; edges eaten off.

Sample 14.—When cast quaked with light tamping.

March 3, 1910.—Apparently in as good condition as when placed.

Dec. 17, 1913.—Condition very good. corners all sharp for full length; face only a little pitted; sides and back hardly touched.

Sample 15.—When cast quaked with light tamping.

March 3, 1910.—A very slight action was noticeable on the front, and the face appeared softer than it should.

Dec. 17, 1913.—Condition good entire length; edges slightly eaten; face pitted; sides and back hardly touched.

Sample 16.—When leveled off showed oily streaks in water on top.

March 3, 1910.—Apparently in as good condition as when placed.

Dec. 17, 1913.—Good all over and on all sides; apparently no eating action has taken place.

Sample 17.—When leveled off showed oily streaks in water on top.

March 3, 1910.—Apparently in as good condition as when placed.

Dec. 17, 1913.—All four sides slightly eaten from high tide to bottom; most of action around low-tide mark; corners eaten; all eating action on mortar; stone seems unaffected; deepest holes less than ¼ in.

Sample 18.—When cast quaked with light tamping.

March 3, 1910.—Apparently in as good condition as when placed.

Dec. 17, 1913.—Good all over and on all sides; back slightly pitted.

Sample 19.—When cast quaked with light tamping.

March 3, 1910.—A slight roughness showed on the front face.

Dec. 17, 1913.—Fair above high-water line, all sides; badly eaten between high and low water; corners all gone, several inches deep in places; back eaten all over to a depth up to 4 ins.; steel partly exposed; concrete soft and crumbly; fair condition below low-water mark.

Sample 20.—When cast quaked with light tamping.

March 3, 1910.—A slight roughness showed on the front face.

Dec. 17, 1913.—Very slightly flaked on all four sides between low-water and half way to high water; below water eaten in a few small spots for 1/16 in. or so; corners all slightly eaten.

Sample 21.—This specimen was lost.

Sample 22.—The lime was mixed thoroughly with dry cement; the specimen when cast quaked with light tamping.

March 3, 1910.—This specimen showed little change. It was, however, cracked when first placed; when examined, this crack showed water leaking out.

Dec. 17, 1913.—Front face badly pitted from mid-water clear to bottom; not quite so bad on lower 2 ft.; at mid-water badly eaten to depth of 4 in.; material soft and dead at this point; sides and back

Table Giving Log of Tests of Various Cements Used in Manufacture of Concrete Test Piles

Kind of cement	Per cent passing sieve No. 100	Per cent passing sieve No. 200	Initial set, hours and minutes	Final set, hours and minutes	Strength, Neat, Lb./in.², 24 hr.	Strength, Neat, Lb./in.², 7 days	Strength, Neat, Lb./in.², 28 days	Strength Lb./in.² 1:3 Ottawa Sand 7 days	Strength Lb./in.² 1:3 Ottawa Sand 28 days	Strength Lb./in.² 1:3 Bank Sand 7 days	Strength Lb./in.² 1:3 Bank Sand 28 days	Loss on ignition, per cent	Silica (SiO$_2$)	Alumina (Al$_2$O$_3$)	Iron oxide (Fe$_2$O$_3$)	Lime (CaO)	Magnesia (MgO)	Sulphuric Anhydride (SO$_3$)	Carbon Dioxide (CO$_2$)
White Portland	94.4	75.0	0-25	3-20	277	549	726	191	319	159	218	1.69	24.58	8.22	0.29	62.70	1.11	1.32	—
Average alumina	94.8	79.6	1-35	4-45	313	660	755	264	360	217	318	0.96	22.08	7.21	2.57	62.60	2.74	1.56	—
High alumina	94.2	76.2	1-45	4-10	342	677	744	272	304	168	211	1.06	21.46	8.50	2.44	61.64	2.58	1.75	—
Low alumina	93.8	78.8	2-10	5-00	312	636	741	184	312	133	271	1.04	23.40	5.61	2.37	62.90	2.51	1.53	—
Iron ore	85.8	82.6	0-45	26-00	000	223 441	641	132	234	108	174	0.91	24.28	0.94	9.08	62.12	0.43	1.75	—
Slag	95.6	78.8	0-35	2-00	315	608	717	194	258	166	181	2.82	20.42	8.04	3.04	62.16	1.63	1.73	—
Average alumina with sea water	94.8	79.6	1-15	4-30	339	690	735	204	—	223	—	—	—	—	—	—	—	—	—
With 0.1 hyd. lime and 0.9 av. alumina	95.2	88.2	0-10	4-00	276	566	717	148	216	117	182	—	—	—	—	—	—	—	—
Av. alumina with 5% clay	99.0	58.0	1-40	4.40	248	723	762	211	255	169	222	—	—	—	—	—	—	—	—
Hydrated lime	—	—	—	—	—	—	—	—	—	—	—	1.32	18.73	0.68		45.88	31.62	—	1.51

equally pitted; crack in middle of worst eaten part.

Sample 23.—Mixed the alum thoroughly with the dry cement; dissolved the soap in water. The specimen when cast quaked with light tamping.

March 3, 1910.—This specimen had a very small crack on its face when placed. When examined it was found to be cracked practically all the way through. The corners were eroded in places, which may have been caused by bumps from a floating obstacle.

Dec. 17, 1913.—Face badly eaten just above low-water mark; all four edges and back badly eaten for three feet below low-water mark; corners at bottom gone; all faces slightly pitted; not much action above mid-water line.

Sample 24.—When cast showed quaking and spattered from light tamping.

March 3, 1910.—The outer face was somewhat soft.

Dec. 17, 1913.—Good above water line; surfaces between high and low tide eaten somewhat; corners eaten all way from high water to bottom; took close photograph of small section showing typical eating; face little worse than sides.

Book Reviews

Bulletin 6 of the Mellon Institute of Industrial Research and School of Specific Industries, associated with the University of Pittsburgh, Pittsburgh, Pa., is devoted to a series of nine papers on the effect of smoke on building material. This is part of the exhaustive smoke investigation being carried on by the Mellon Institute. The bulletin is edited by Raymond C. Benner, Ph.D., chief fellow and chemist, who is in charge of the work. The subjects treated, each being covered by one paper, are: Chemistry of soot and the corrosive products of combustion; effect of smoke on outside painting; effect of smoke on paint coatings; effect of smoke on stone; stone and the smoke nuisance, with special reference to the protection of stone; effect of smoke on metal; the question of light and smoke; the effect of smoke on the interior of buildings, and limitations placed by smoke upon the means of architectural expression. The bulletin contains fifty-eight pages, 6 x 9-in. in size, and is bound in paper. (Pittsburgh, Pa., University of Pittsburgh. 25 cents.)

MATHEMATICAL THEORY OF INVESTMENT. By Ernest Brown Skinner, Associate Professor of Mathematics in the University of Wisconsin. Cloth, 5¾ x 8¼ in.; 245 pages, with diagrams and tables. New York, Ginn & Company. $2.25 net.

Professor Skinner brings together in this book the mathematics of business, it might be called—the development of formulæ covering interest, annuities, amortization, valuation of bonds, sinking funds and depreciation, building-and-loan association operations, and life insurance. The volume covers all ordinary problems, and, as the nature of the subject would indicate, does not go into higher mathematics. In fact, those familiar with algebra, the various series and logarithms, should have little difficulty in deriving practically all the equations themselves. The book, therefore, is intended primarily for classroom purposes, and, in fact, is based on a course of lectures given annually for the last five years at the University of Wisconsin. Engineers will be chiefly interested in the chapters on amortization, valuation of bonds, and on sinking funds and depreciation. For those concerned with problems under these heads the work should be useful for reference.

GENERAL SPECIFICATIONS FOR CONCRETE AND REINFORCED CONCRETE, Including Finishing and Waterproofing. By Jerome Cochran. Cloth, 6¼ x 9 in.; 274 pages; 18 illustrations. New York, D. Van Nostrand Company. $2.50 net.

(Reviewed by F. H. Constant, Professor of Structural Engineering, University of Minnesota.)

While recognizing the good work done by committees of national societies and individuals in the production of general specifications for concrete and reinforced concrete, the author states his belief that, owing to the still divergent views as to substance, form, scope and phraseology of such specifications, there is still room for further work in this field based upon individual experience in design and construction. This book is the outcome of this belief. It is much more voluminous than the requirements of any individual case would demand and is intended as an aid to practising engineers and architects in writing specifications for special works.

A short introduction covering the elements of concrete construction is followed by nine chapters on the respective subjects of concrete materials, proportioning and mixing forms and centering steel reinforcement, transporting and placing, finishing surfaces, waterproofing, design and reinforced-concrete building construction. The book closes with an appendix containing the usual formulæ for beam design based upon linear variation of stress across the section of the beam.

To the designing engineer or architect Chapter 8 on design will be of special interest. It covers loads, moments in slabs and girders, working stresses and the general details of building construction, arches, slab and girder bridges, culverts, retaining walls, piers and abutments, reservoir walls, etc.; also considerable matter pertaining to drafting-room standards and methods of making working drawings, bills of material, checking and handling orders. Reinforced-concrete drafting as it is now practised upon a commercial scale in large offices is a recent art about which little has, as yet, been written.

In order to compare the author's working stresses with those of the joint committee parts of the latter's specifications, as published in revised form in the "Proceedings" of February, 1913, of the American Society of Civil Engineers, are reproduced in fine print in the footnotes. The author uniformly leans to greater liberality. In the judgment of the reviewer the stresses allowed are too high to lead to good, safe and conservative design. There are also many contradictions and ambiguities.

The book covers a vast amount of practical detail and much matter of interest and value to all who have to do with concrete design and construction.

While the author has chosen to present his material in the specification form, the book is in reality a treatise on concrete. It would have been more interesting reading, much repetition would have been avoided and the book made less bulky if the straight narrative style had been adopted. The specification form requires the mandatory phraseology, and yet much of the subject matter is merely descriptive or advisory, and all three forms frequently follow with startling consecutiveness in the same paragraph.

In further criticism of the style of presentation it can be said that there is much repetition of ideas and statement of obvious facts. Many clauses are given with fixed rigidity when they are necessarily subject to variation. Some belong to the contract rather than to the specification; many are merely economic in character and intended as advice to the contractor, but of no especial interest to the engineer. Many instruct the engineer as to what theoretical processes he must use to create his design, or how the draftsman shall make his drawings.

In spite of some of these obvious defects the book is, as a whole, a valuable addition to the literature upon this subject. One of its best features is the extensive and up-to-date bibliography which closes each chapter.

Letters to the Editor

Poetry and Engineering

SIR: Alfred Noyes, the English poet, who has just accepted a chair on the Princeton University faculty, was asked by a reporter, "What place should poetry have in the life of a college student?" "What place," asked Mr. Noyes, in turn, "should poetry have in the life of any man?" That exchange of questions may not appear, offhand, to have much significance to engineers. It is just because engineers would be likely, by reason of their training and everyday work, to miss the importance to them of Mr. Noyes' remark that I am led to express a few ideas that come to my mind.

When I asked myself the question, "What place should poetry have in the life of any man?" I saw that Mr. Noyes did not mean to use poetry in its strict sense. He might have said: "What place has literature in the life of any man?" And I said to myself, "And especially in the life of an engineer?" I doubt if there is any profession the members of which are more poorly grounded in English literature than that of engineering, nor do I know any profession whose members could use a literary training to better advantage.

All of the engineering courses in our colleges include instructions in mathematics, both pure and applied, which is as it should be. All such courses include shop and field practice aplenty, which is also as it should be. Most engineering students are required to study one or more foreign languages, and that would be all right if the English language were not almost entirely neglected. I would not criticise the amount of time students are made to spend over a drafting board if they were also taught how to draft a good letter. Some very able theses are prepared as a part of the curriculum; the language in which they are couched, however, is given little weight by the professor who wields the blue pencil. Practically none of the engineering courses requires public speaking; hence it is proverbial that an engineer cannot talk without a blackboard and a piece of chalk, whereas these conveniences are not always available at a board of directors' meeting.

A little less stereotomy, geodesy, least squares and astronomy and a little more Alfred Noyes and the humanities might improve the personal address of the engineer, widen his circle of acquaintance and incidentally make it necessary for that special committee of the American Society of Civil Engineers to revise its report on the average wage.

I am perfectly well aware that four years is not long enough in which to teach the principal scientific topics, but I am also convinced that the issue had better be met either by lengthening the course to six years, as was done in most medical schools, or by reducing the technical work to three years and adding one year of classical work, as was done in some schools of law. Some such change will come eventually, and would come with more profit now.

I am also aware that this is the age of specialization, and I will go further and say it is the age of over-specialization. So many men have chosen a narrow field and have shut their eyes to the service they could render to society and to themselves, did they but choose to apply their training to other lines, that engineers have become a drug on the market. The bread line of engineers, hat in one hand and application blank in the other, grows constantly longer as it waits in the outer office. The wages of skilled mechanics have increased from 20 to 40 per cent during the last ten years. Common labor receives about 15 per cent more than it received a decade ago.

Of course, I do not believe that the introduction of classical study into the technical courses of the colleges would be the catholicon for all evils. I do believe that lack of breadth is the engineer's greatest handicap, and I further believe that the place to establish a proper horizon is at school. The mind of the youth is particularly susceptible and impressionable, and it is wrong to mold that mind along straight and narrow lines. It is unfair to teach that student that bridges are built of stone and steel and not let him know there is also a deal of dollars, human nature and local color which must enter into the design. It is unfair to teach that student in one room that mathematically the shortest distance between two points is a straight line, unless he is also taught in another that, historically, there is no such thing as a straight line. It is neither reasonable nor right that a student's course should be such that he be sent into the world with his head fastened rigidly to his shoulders, unable to look about, but forced to look continually in one direction.

As Mr. Noyes well says, "If you eliminate literature, you shut up twenty gates to knowledge." Why, then, should engineers not pass within these gates early in life and cultivate a love for books and all that is recorded therein? Why should engineers deny themselves the inspiration which the contemplation of the best thought of man affords? Why should engineers make of themselves calculating machines—automatons clad in khaki? Why would they not render better service, and occupy a more dignified position in the community, if they emerged from their chrysalids of iron and steel, essayed some charm and grace and learned to feel more at home in evening clothes?

C. S. Rindsfoos,
Secretary-Treasurer the Foundation Company.
New York City.

U. S. Government Testing Flume

Sir: In Vol. 1, No. 1, page 6 of the "Journal" of the Boston Society of Civil Engineers is printed an appeal to the Boston Society of Civil Engineers to cause a Government testing flume to be established at Niagara Falls. As the Engineering Record has printed an abstract of this appeal (March 7, page 273), my comments on this appeal submitted to the society Jan. 27 may interest your readers and follow herewith:

"It requires temerity of a high order, and a meritorious object held in view, to comment on the address to the society, printed on pages 6 to 9 of the first number of the "Proceedings" of the Society—signed as it is by fifteen names each of which carries weight and respect in the engineering profession. Nevertheless, as the proposition presented is evidently intended to bring out discussion among the members and elsewhere, and as the writer has had some experience in the subject matter, he thinks it proper to submit the following to the society:

"In 1881 he built the Holyoke testing flume, referred to in the mentioned article, and had charge of its operation until he left Holyoke in 1889. Further, for the last five or six years he has made an especial study of hydraulic laboratories built and to be built by educational institutions, has designed such, and has advised with regard to their construction.

"The subject of a new testing flume to be built is thus well developed and in all its parts present in his mind. It is not enough to say that the use of water for testing wheels 'would be intermittent and of comparatively short duration.' This fact is a governing feature in the choice of location for and design of testing flumes, and cannot be too strongly emphasized. The time required to set up for testing and again for taking down wheels, or while the flume is wholly idle, is probably from twenty to forty times that required to test. It thus becomes essential or else economical to be able to utilize the power made available at a testing flume during the long times when experiments are not actually in progress.

At the German testing flume such power is then transmitted to the factory owning the testing flume. Conversely, at the Paris, France; Madison, Wis., and other hydraulic laboratories the power needed to produce the fall or pressure required during the short times of actual experimentation is applied from without only during those brief times—at Paris by means of transmitted electric current, paid for by the kilowatt-hour of actual use; at Madison by means of steam conveyed from the University of Wisconsin central heating plant. In this way great liberty of location is attained. In Paris the hydraulic laboratory is in a cellar, in the middle of a large city. At Madison it is on the shore of an inland lake, in a flat country. In both and other similar cases the fall required is a pump-produced, artificial fall.

"It is easy, by means of an overflow standpipe, or otherwise, to produce that desideratum in all hydraulic experiments—a steady head. The way is also left open to produce a head of any desired magnitude and to create new such heads later on. That the testing flume should have facilities for making also tank gagings and that it should be housed so that work may go on in it night and day, summer and winter, goes without saying.

"Now, then, if all the above be taken into account, and retaining the idea of having the U. S. Government construct and conduct the testing flume, the Bureau of Standards is evidently the proper Government agency to do this work, and Washington is just as good a place where to locate the flume as anywhere else."

Further comment could be made. Niagara Falls is, to be sure, a name to conjure with; but those who know the situation as respects land and water rights at Niagara Falls also know that to establish any kind of hydraulic power there always has been most difficult, and is now much more difficult than ever before. To illustrate: Where at Niagara Falls could such a testing flume be placed?

As is well known, certainly to those above referred to, there are two water-power companies on the American side—the Niagara Falls Hydraulic Power Company and the Niagara Falls Power Company—and both of them could utilize and send out to the public power generated from much more of the flow of the river than Congressional inhibitions now permit them to utilize and send. If these companies cannot furnish sites for the hydraulic generation of power at Niagara Falls, where at Niagara Falls shall the proposed testing flume be placed?

As is also well known, works for the generation of hydraulic power need land or real estate to come into being fully as much as they need water. The land, moreover, must be properly situated. Outside of the State of New York's Niagara Falls Park, which under the constitution of the State cannot in any manner be occupied or alienated, there is, between head water and tail water at Niagara Falls a neck of land, say 1½ miles wide. Either there must be a short tailrace and a long headrace or else a short headrace and a long (tunnel) tailrace. The cost of hydraulic-power plants at Niagara Falls has probably been greater per kilowatt-hour produced than on the average throughout the United States—this notwithstanding that those plants are large ones, of 200,000 hp and over. An independent 5000-hp plant is not to be thought of on the score of cost.

It is also history that until the genius and perseverance of William B. Rankine supplied land for the proposed power company at Niagara Falls, in 1889, scores of projects for power development there, which preceded the organization of the Niagara Falls Power Company, came to naught, in spite of the enthusiasm generated in the breasts of their projectors at the sight of so much water "going over the falls." It will hardly be practicable to repeat Mr. Rankine's work prior to 1889.

Some one may say that the United States could take the needed land by right of eminent domain. Apart from the legal question whether the taking of land for a testing flume would be a taking of land for a "public use," there would be the difficulty of finding such an available site for it and its water connections at Niagara Falls at any thing but a grossly impracticable cost, as has already been explained, even if the power to be generated for testing purposes should be made available for distributing electricity in competition with other sources of such power on both sides of the river at Niagara Falls during the 19/20 or 39/40 of the total time, when it is not needed to make tests.

We come back to the proposition first submitted—that before a new testing flume can be inaugurated its advocates and builders must "count the cost"; and so counting, they will probably conclude that convenience of location, coupled with being content with an artificial generation of fall, or head, is vastly more economical than having regard to a natural fall or head only.

With the writer it is also a question whether the U. S. Government should do this thing. In his opinion a union of wheel builders, together with such contributory funds as patrons of the work may be induced to supply, would give better satisfaction, in the long run, than the conduct of such a public testing flume by a bureau of the Government.

CLEMENS HERSCHEL,
New York. Consulting Engineer.

Specifications for Factory Timbers

SIR: The abstract of a paper by F. J. Hoxie, appearing in the Engineering Record of Jan. 17, page 66, and the subsequent letters to the editor concerning this paper are of interest because they affect one of the most valuable resources in this country. In this letter we will consider the paper from its commercial aspect as affecting the engineer, contractor and owner.

Mr. Hoxie states that during the last three years $100,000 has been expended in repairing damage due to dry rot in mills insured by the Associated Factory Mutual Fire Insurance Companies. This is a large or small amount according to its relation to some other amount. The total insurance in force with the associated companies is $2,652,000,000, covering 3020 plants. The 1913 cut of yellow pine was 9,500,000,000 ft., and its value at the mills was $145,000,000. The damage, then, for three years was scarcely appreciable. The damage is confined to a certain class of mills operated under conditions of excessive humidity and its attendant high temperatures. These mills are located in one section of the country, which, by reason of certain trade conditions, depends upon a certain source of supply for its factory timbers.

It is apparent that the conditions under consideration apply to a limited field of activity and are in no degree alarming. It is, however, a condition that demands attention, and this discussion will result in corrective measures being applied for the benefit of all concerned, for which Mr. Hoxie will be primarily responsible.

The damage seems to be confined to buildings of comparatively recent construction and is evidently due to a change in the quality of the material used. Mr. Hoxie states that "in a lot of large timbers for the frame of a new mill will be found nowadays scarcely anything but North Carolina, Cuban or short leaf pine." This is a condition prevailing in the North Atlantic States, and is due largely to trade conditions. There is nothing compulsory in the use of lumber as above described.

The distribution of the Southern yellow pines may be of interest, and the table in the next column is from the report of the U. S. Bureau of Corporations entitled "The Lumber Industry, Part 1, Standing Timber," page 76, 1913.

DISTRIBUTION OF YELLOW PINE
(In billions of board feet)

State	Yellow Pine Total	Yellow Pine Long Leaf	Yellow Pine Short Leaf
Missouri (part)	1.1	...	1.1
Arkansas	26.0	...	26.0
Texas	44.9	22.4	22.5
Louisiana	67.7	52.5	15.2
Mississippi	62.4	47.6	14.8
Alabama	38.0	25.6	12.4
Florida	59.1	58.2	.9
Georgia (part)	31.7	18.5	13.2
South Carolina (part)	19.2	4.6	14.6
North Carolina (part)	25.6	2.9	22.7
Virginia (part)	8.7	...	8.7
Total	384.4	232.3	152.1

Mr. Hoxie's final conclusions, (d) "True long-leaf pine is as good now as it ever was," is true, but his conclusion (e), "the general run of Southern pine is much poorer now than in former years," is not correct. The above table shows that the timber Mr. Hoxie mentions is produced in a territory which has a limited supply of lumber as compared with the supply of virgin timber to be found in the Gulf States. The New England States are simply depending on the wrong source of supply.

There is available to-day a greater amount of virgin long-leaf, short-leaf and loblolly yellow pine of the very best quality than there ever was in the history of the yellow pine industry. This is due to the fact that larger forest areas are in contact with more railroads, more producers are in the field, better equipped financially, in modern plants and otherwise; the possible annual cut is greater. I think that the recent inspection of the Southern forests and mills by Mr. Hoxie will convince him that this is true.

In the early days of the production of yellow pine in the Mississippi Valley the producers owned or were interested in retail yards in the larger cities, and the result was a close contact between the producer and the consumer. To-day the producer reaches the consumer only through the wholesale and retail dealers. There is no assurance that a specification made by an engineer reaches the producer, and the retail dealer in many instances delivers an article conforming to his idea as to what class of timber he can get the engineer, architect and contractor to accept. A Chicago contributor to this discussion states that "the quality of structural timber being offered in the Chicago market has deteriorated 25 to 40 per cent in the last few years." This may be the case with reference to some engineers and architects, but I find that those architects and engineers in St. Louis and Chicago whose practice comprehends the consumption of millions of feet of yellow pine annually do not complain of being unable to get first-class material. To procure high-grade material it is only necessary to provide proper specifications and rigid inspection.

The commission of engineers and architects which prepared the existing building code in force in Chicago was far above the average of such sources from which our building codes are produced. They proposed reasonably high fiber stresses based on a reasonable specification describing the physical properties of the wood. This was submitted to a committee of retail lumber dealers who, according to a member of the commission, actively "opposed any ordinance which would prevent the lumber dealers from providing any kind of material for the Chicago market. The consequence was that the Chicago limit was set low."

Chicago is suffering from an unscientific system of marketing. It is sometimes the case that a dealer dilutes a bill of yellow pine lumber with Western and Norway pine if it is supposed that the purchaser will not give it rigid inspection. This same condition obtains in the merchandising of any other material or product of manufacturing. A "deteriorated quality" only confronts those who are unable to properly specify and inspect the article purchased.

In the Central States a bill of timbers for an operation of any considerable magnitude is manufactured for that special order and is not kept in stock at the mill or lumber yard. As soon as the timbers are cut they are loaded on the "ramps" and remain there until a carload is ready for shipment. As these timbers are generally on the "ramps" not to exceed ten days there is little danger of infection with the dry-rot fungus. These timbers are bright and sound when shipped and within a few weeks are installed in the building. Thus the elapsed time from a growing tree to a timber placed in a building is from three to eight weeks. Mill operators generally are aware of the danger from dry rot and promptly remove the waste that might decay.

It should be apparent to any observer of old buildings, forests or other places where timber is found that resinous woods resist decay. Whether this is due to any antiseptic quality of the resin or to its waterproofing ability is of no real importance. It is important, however, to determine what percentage of resinous content will prevent dry rot. It is to be hoped that the Forest Products Laboratory will be commissioned to conduct such an investigation.

I have been unable to learn of any building in the Central States being destroyed by dry rot as described by Mr. Hoxie. This is evidently due to the use of a better quality of timber and occupancy of the buildings. In fact, it is hard to conceive of conditions which would permit the use of such timbers as he illustrates in his paper. The whole trouble seems to be the result of poor specifications and inspection in connection with modern purchasing methods. Corporations to-day are prone to indulge in purchasing agents to whom all wood is lumber and all prices are either high or low. Intelligent purchasing is always accompanied by specific knowledge.

It is the writer's personal opinion that structural timbers should be sold by the producer direct to the contractor or consumer on original specifications. I think that experience and unbiased observation will justify the following conclusions:

(a) There is more high-grade yellow pine timber available to-day than at any previous time.

(b) Specifications for structural grades are necessary.

(c) That these grades be based on strength and durability without reference to botanical species.

(d) That the strength and durability be measured in terms of density, resinous content, spring wood, summer wood or other physical properties germane to the proposition.

(e) That antiseptic treatment be required under certain conditions.

(f) That all structural timbers must be inspected by competent inspection bureaus and that such timbers be branded as suggested by Mr. Weiss.

It is to be hoped that yellow-pine timbers will soon be specified, graded, inspected and marketed in a manner befitting its position as the premier structural wood of the world. For this result thanks will be largely due to Mr. Hoxie.

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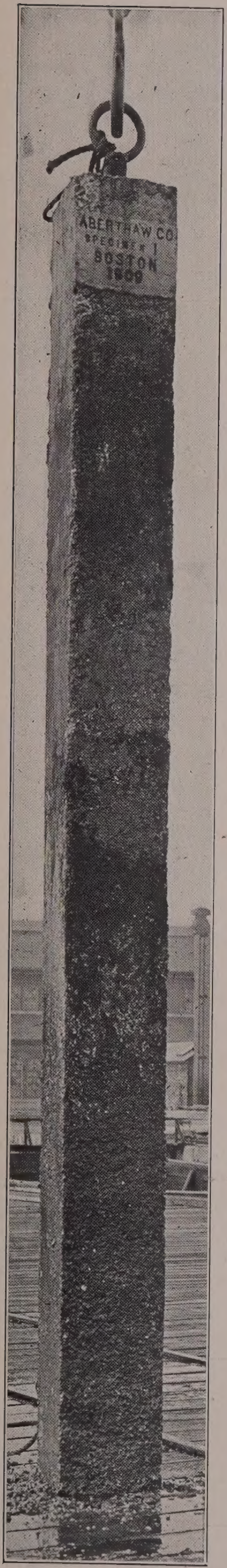
Chicago.

Supplement to Engineering Record, March 21, 1914, accompanying article entitled "Action of Sea Water on Concrete," page 344.



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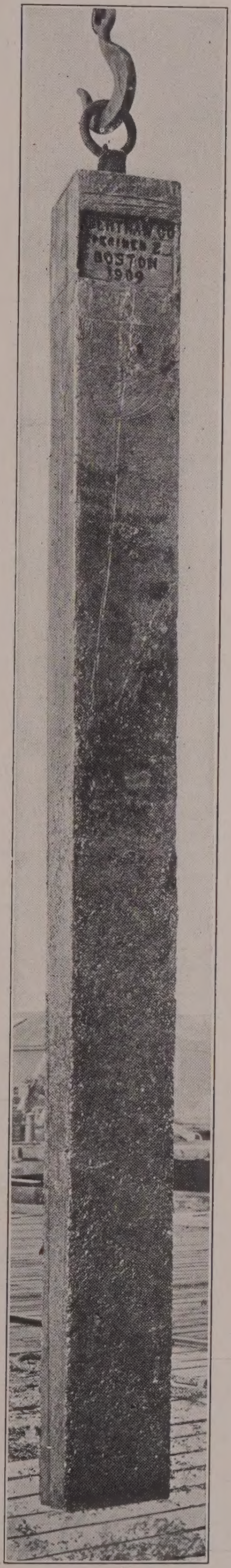

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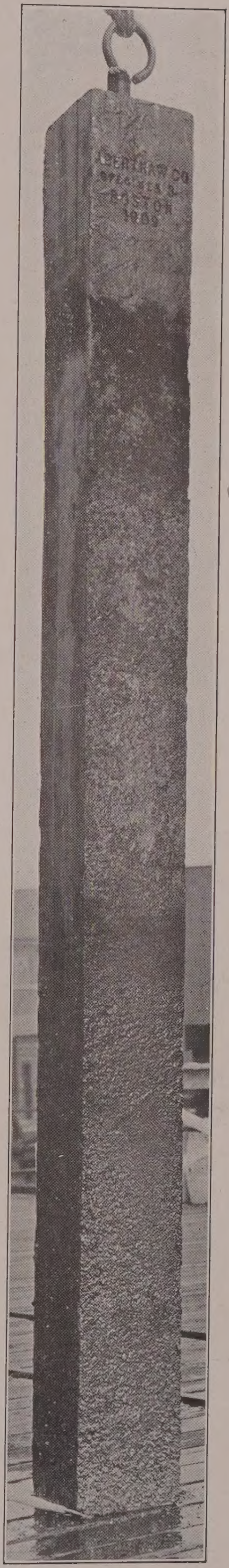

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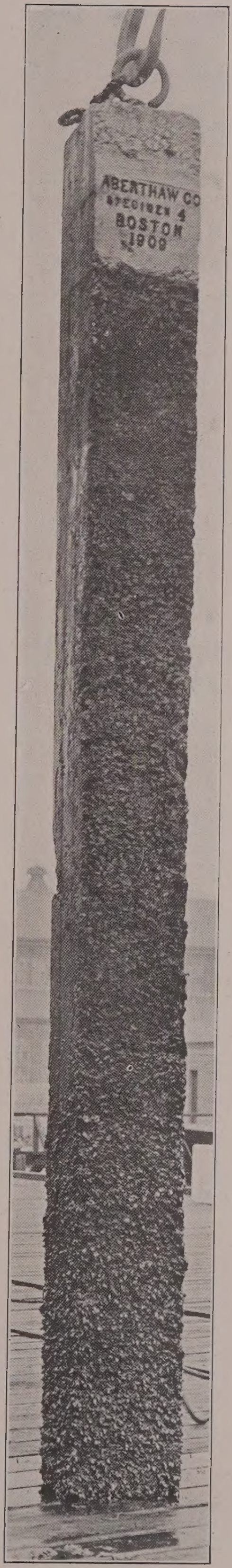

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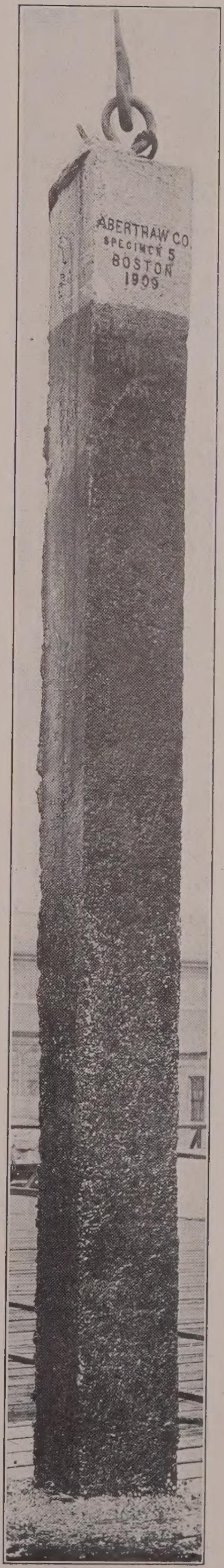

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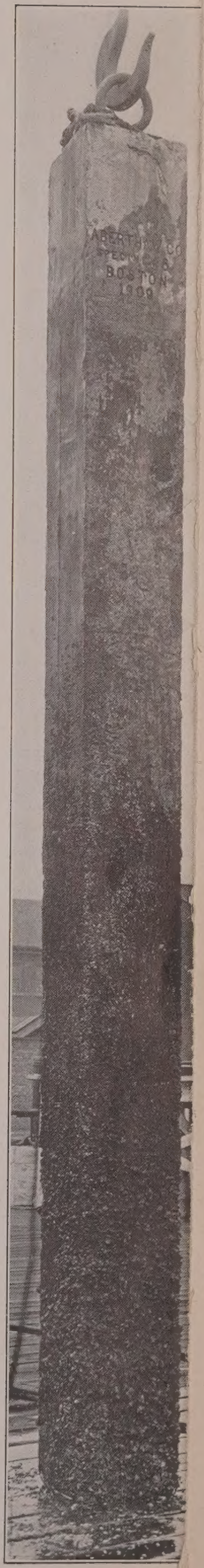

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